Quality Assurance Project Plan
and
Sampling and Analysis Plan

for

Redlands Shooting Range
2125 North Orange Street
Redlands, California 92374

August 10, 2011
Project No. 11059-01

Prepared for:
Environmental Protection Agency
2445 N. Palm Dr. Suite 100
Signal Hill, California 90755
Phone: 562 889 2572;

Prepared by:

GeoMat Testing Laboratories, Inc.
9980 Indiana Avenue, Riverside, California 92503
(951) 688-5400

SECTION "A" PROJECT MANAGEMENT

A-1 Title and Approval Sheet

Quality Assurance Project Plan
and
Sampling and Analysis Plan

Redlands Shooting Range
2125 North Orange Street
REDLANDS, CALIFORNIA 92374

Project No. 11059-01

Submitted by:
GeoMat Testing Laboratories, Inc.

Signature	Date
Haytham Nabilsi	Project Manager
Name	Title
Signature	Date
Jim Tyner	Owner's Representative
Name	Title
Signature	Date
Robert Wise	EPA Representative
Name	Title

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U.S. Environmental Protection Agency (EPA), 2006. "Guidance on Systematic Planning Using the Data Quality Objectives Process, EPA QA/G-4." Office of Environmental Information. Washington, D.C. Available Online at: http://www.epa.gov/quality/qs-docs/g4-final.pdf>.

U.S. Environmental Protection Agency (EPA), 1998. "Guidance for Quality Assurance Project Plans, EPA QA/G-5." Office of Environmental Information. Washington, D.C. Available Online at: <http://www.epa.gov/quality/qs-docs/g5-final.pdf>.

A-3 Distribution List

Task	Name	Address
EPA Representative	Mr. Robert Wise	EPA Long Beach 2445 N. Palm Dr. Suite 100 Signal Hill, CA 90755 562 889 2572;
Owner Representative	Mr. Jim Tyner	GroupRes, Inc 601 E. Daily Dr. Suite 300 Camarillo, Ca 93010 800 498 0016 Ext. 101
Project Manager Q/A Officer	Mr. Haytham Nabilsi, PE	GeoMat Testing Laboratories, Inc. 9980 Indiana Avenue Suite 14 Riverside, California 92503 951-688-5400
Laboratory Project Manager	Lorenzo Rodriguez	E.S. Babcock and Sons, Inc. 6100 Quail Valley Court Riverside, CA 92507
Field Team Leader	Tamer Khalil	GeoMat Testing Laboratories, Inc. 9980 Indiana Avenue Suite 14 Riverside, California 92503 951-688-5400
Data Processor	Omeed Pour	GeoMat Testing Laboratories, Inc. 9980 Indiana Avenue Suite 14 Riverside, California 92503 951-688-5400
Data Reviewer	Mr. Ibrahim Massoud, PE	GeoMat Testing Laboratories, Inc. 9980 Indiana Avenue Suite 14 Riverside, California 92503 951-688-5400

A-4 Project/Task Organization

Haytham Nabilsi is the Project Manager and will manage personnel in this study.

Tamer Khalil will be the field manager and will direct the field team on sample collection and take them to E.S. Babcock and Sons laboratory within holding times. Mr. Khalil is also responsible for developing and maintaining the QA Project Plan in case of discrepancy between plan and field conditions.

Ibrahim Massoud will review sample data for this project.

Lorenzo Rodriguez is the Laboratory Manager for E.S. Babcock and Sons, Inc. Under his authority samples will be analyzed and the results verified.

Stacy Fry is the QA Officer for E.S. Babcock and Sons, Inc.

Field Investigators- will walk the wash and locate sampling sites. As an aid to Mr. Khalil they will also collect samples.

Robert Wise will review and approve the QA Project Plan and any subsequent revisions, in terms of project scope and objectives.

A-5 Project Definition/Background

The Santa Ana River Basin contains valuable ecological, economic, recreational, and cultural resources. The river is also a habitat to many species. At the subject site location two of these species, San Bernardino Kangaroo Rat and the Santa Ana River Wooly Star Plant were identified as endangered species.

At the subject site Redlands Shooting Club, clay targets are typically launched for trap or skeet shooting in a trajectory that causes a significant portion of the lead shot fired at the targets to fall into the Santa Ana River Floodplain and within the rat habitat and the established Santa Ana Wooly Star Preserve.

Over the years, continued target shooting over the area has leads to a significant accumulation of lead shot immediately adjacent to the Shooting club. Because the lead is relatively heavy, the lead shot becomes embedded in and mixed with the sand, silt material within the drop zone.

As time goes on, the amount of lead in the drop zone steadily increases. Currently, a significant concentration of lead shot is found in the drop zone, from the surface to a depth of eight or more inches. Lead concentrations are highest in front of the target area, but downstream water transport of lead shot has occurred during periods of heavy rain when the secondary water channels on site are active.

The area impacted by the lead pellets is subject to a number of land ownership and regulatory jurisdictions, including the US Army corps of Engineers-Corps, the US Fish and Wildlife Service-USFWS, the California Department of Fish and Game-CDFG, the San Bernardino Flood Control District-SBFCD, and the Environmental Protection Agency- EPA.

The EPA's focus on lead shot is through the Hazardous Waste Compliance Program, which implements the Resource Conservation Recovery Act and amendments to that act.

Site investigation by ENVIRA determined that the federally listed as endangered San Bernardino kangaroo rat- SBKR (*Dipodomys merriami parvus*), and the Santa Ana river wooly star (*Eriastrum densifolium sanctorum*) were present on site. Potential habitat also occurs on site for the slender-horned spine lower (*Dodecahema leptocerus*); and water flow from the ephemeral drainage on site are within the watershed that supply water to critical habitat for the endangered Santa Ana river sucker (*Catostomus santaanae*).

Environmental Reclamation Services-ERS had been retained by the Redlands Shooting Club to recover and recycle lead shot from the drop zone of the Redlands Shooting Park. ERS conducted lead shot recovery from the drop zone within the project area sometime in the past. Reclamation of the lead shot from the floodplain would reduce potential direct environmental hazard. To further reduce the lead pellets from falling in the river basin the owner is proposing to install a heavy duty pellet curtain stop.

A-6 Project/Task Description

The purpose of this project is to identify the horizontal and vertical extent of lead in the soil

For this project, the action level for lead in soil will be 400 micrograms per gram (µg/g). This is the lower threshold at which EPA has issued guidance based on best currently available information. If this action level is exceeded remedial action will be recommended.

Visual surveys were conducted prior to the beginning of the Project to identify size and shape of the lead pellets.

Visual Sample Plan software was used as a basis for targeting and establishing sampling locations. From this the Project team determined that 107 sites would be included in this portion of the study and that sites would be sampled daily until all the samples are collected.

The following table gives Project activities and their anticipated date of initiation and completion.

Activity	Name/Group	Anticipated date of initiation	Anticipated Date of Completion	Comments
Visual Reconnaissance	Haytham Nabilsi Jim Tyner	7/26/2011	7/26/2011	
QA Project Plan Approval	Robert Wise	9/1/2011	9/21/2011	
Site Determination	Tamer Khalil	9/22/2011	9/26/2011	
Sampling Begins	Tamer Khalil and Field Investigators	9/27/2011	10/26/2011	Daily at 6:00 am to 8:00
Data Review	Ibrahim Massoud	9/27/2011	10/27/2011	
Laboratory Testing	Lorenzo Rodriguez	9/27/2011	11/1/2011	
Report Preparation	Haytham Nabilsi	11/1/2011	11/14/2011	
Data Validation	Lorenzo Rodriguez	Following Data Review and Verification	12/1/2011	

The dates shown in the table above are estimates only. Because of the limited time when the club is not active and possible rain events, delays may occur. Sampling events may be delayed in the cases of serious rain events.

A-7 Quality Objectives and Criteria

DQOs are qualitative and quantitative statements developed by data users to specify the quality and quantity of data needed from a particular data collection activity to support decisions or regulatory actions. DQOs may be established for both quantitative and qualitative tasks.

This plan provides methods for control and review of data collected during field events so that the sample collection, sample analysis, and data analyses are scientifically sound, technically, and legally defensible, and of known, documented quality. The data must be of sufficient quality to make the primary project decisions (described in Table 1).

The DQO development process outlined in "Guidance on Systematic Planning Using the Data Quality Objective Process" (EPA 2006) was followed to develop DQOs for the project.

The seven steps required to achieve appropriate DQOs for the project are:

- Step 1: Statement of the Problem
- Step 2: Identification of Decisions
- Step 3: Identify Inputs to Decisions
- Step 4: Definition of Study Boundaries
- Step 5: Development of Decision Rules
- Step 6: Specification of Limits on Decision Errors
- Step 7: Optimization of Design for Obtaining Data

Details for each of the seven DQO steps are presented in tabular format in Table 1

A-8 Special Training/Certifications

The field team assigned for this project has the following capabilities:

1. Certified soil samplers
2. Aware of the 'clean hands-dirty hands' technique

No special certification is required. The technicians are available to perform the work.

A-9 Documentation and Records

Mr. Haytham Nabilsi is responsible for writing, maintaining and distributing the QA Project Plan. The most updated QA Project Plan will be mailed to the persons on the distribution list.

The data report package from the laboratory will include the data in a printed PDF format. Each package submitted will give the lab number and data for one site. Other records will be attached to each sample in accordance with the laboratory QA/QC manual. Record Keeping is also shown in the Laboratory QA/QC Manual.

Sampling records generated by this project are:

1. Field Log
2. Chain of Custody
3. Sample Analysis Laboratory Reports and QA/QC Procedures
4. Corrective Action Report

All records will be copied and transferred to the Redland Shooting Range (Owner).

SECTION "B" MEASUREMENT/DATA ACQUISITION

The samples collected under this plan will follow the procedures detailed in the following sections. Sampling activities will occur as required in this plan.

B-1 Sampling Process

B-1.1 Sampling Location

Soil samples will be collected from 4 feet below ground surface. The sample locations are depicted on Plate 1. All sample locations will be documented in Daily Field Activity Logs. If appropriate, sampling activities will also be documented with representative photographs.

B-1.2 Sample Collection

Soil boreholes will be advanced using a hand auger. Sampling will be conducted in accordance with GeoMat's "Technical Standard Operating Procedures for Surface and Shallow Subsurface Sampling" presented in Appendix A

B-2 Sampling Methodology

Each sample will be placed in the appropriate container as shown in Table 2. Samples will be labeled with a unique identifier and processed for shipment to the laboratory.

The sampling methodology for the collected soil samples is as follows:

1. Decontaminate non-disposable sampling equipment or ensure that non-disposable sampling equipment has been decontaminated prior to use.

2. Don a new pair of nitrile, powder-free disposable gloves for each sample.

3. Drive auger to 4 feet and collect soil sample. No interval sampling is required for this project.

4. Extract sample from the sampler and place in jar.

5. Affix a pre-printed label to side of the jar and place in a labeled Ziploc® bag.

6. Place the bag containing the jar in a cooler of double-bagged ice and preserve at approximately 4°C.

B-3 Sample Handling and Custody

This subsection describes the requirements for sample containers, handling, custody, packaging, and shipping.

B-3.1 Sample Containers

Soil samples will be placed in pre-cleaned containers specified for each analytical method. Table 2 provides additional information on sample container type and volume as well as preservatives and holding times.

B-3.2 Sample Handling

Approved site-specific personal protective equipment, such as gloves, will always be used when collecting a sample to prevent cross-contamination from sample to sample and to assure worker health and safety. A new pair of gloves will be used to collect and handle each sample to prevent sample to sample cross contamination. Samples will be securely placed in a cooler with water ice (not blue or chemical ice) for delivery to the contracted laboratory.

B-3.3 Sample Labeling

Each sample will be assigned a unique Sample Identification Number using the following designations:

- "RSR" – Redlands Shooting Range sample
- "MMDDYY" - Sample Date
- B01 – Boring Number
- "0.0" - Sample Depth

The following Sample Identification Number would indicate a sample collected from the site on September 7, 2011 from boring 1 at a depth of 4 feet:

"RSR-090711-B01-4.0’

The sample collection date and time, requested analyses, client, and sampler will also be identified on the label. In addition to labeling the individual sample containers, the Ziploc® bags containing sample containers will be labeled with the sample date, time, and identification number for easy identification during packing and shipping.

B-3.4 Sample Custody

Each sample will be entered onto a Chain of Custody form and recorded in accordance with the contracted laboratories for this project. Samples will be transported to the laboratory via our vehicle and personnel, transferring custody to the laboratory at that time. If a commercial carrier or courier is used, the laboratory will check the custody tape on each shipping container upon receipt to ensure that the shipping container has not been tampered with. Custody tape will be placed on shipping containers prior to shipment. Laboratory couriers will provide a signed sample receipt with a discrete tracking number when they pick up samples at the site. After ensuring that the shipping container has not been tampered with, the laboratory representative will sign the Chain of Custody noting the time and date of receipt, and thereby assuming custody of the samples.

B-3.5 Sample Documentation

Field personnel will document sampling activities on a Daily Field Activity Log. Each page of the log will be signed and dated by the individual(s) making entries. Field personnel will enter notes and observations on the log and will also take photographs (if needed) to document field activities. A record of the photographs, including the date of the photograph, photographer, frame number, and subject will be maintained on a photograph log.

Samples will be documented daily on a sample tracking log. The tracking log will list the sample number, type, location, specific location, shipment date, the Chain of Custody number, the laboratory location, and the parameter(s) to be analyzed. Any discarded samples will be noted on the sample tracking log.

B-3.6 Temperature

Samples will be stored at 4 °C ± 2 °C prior to shipment to the laboratory. Shipping containers will be packed with ice before shipment to ensure that the samples arrive at the laboratory chilled to 4°C ± 2°C. The ambient temperature of the sample shipping containers, when received at the laboratory, will be measured from a temperature blank only and recorded on the Chain of Custody form. Sample shipping containers received at the laboratory within 4 hours of sample collection and at less than or equal to 10° C will not be subject to normal temperature requirements.

B-3.7 Sample Packaging and Shipping

Samples will be packaged and shipped in accordance with the certified laboratory procedures. The sample container will be placed in a shipping container (typically a cooler) allowing sufficient room between the samples to place ice and/or packing material. The samples will be maintained under proper Chain-of-Custody documentation. The sample container will be tightly sealed and custody tape placed around or over the top. The container will be inspected for integrity and the drain plug sealed with tape.

The contracted laboratory will be notified 24 hours prior to sample collection to arrange for sample pickup at the site or for delivery to the laboratory. The container will be marked and labeled, and custody relinquished to the courier.

B-4 Decontamination of Sampling Equipment

Dedicated sampling equipment will be used where possible to minimize decontamination requirements. Non-dedicated sampling equipment (i.e., core sampler, sleeves, etc.) will be decontaminated between sample locations by the following steps:

- Wash with soap and water
- Rinse with tap water
- Rinse with deionized water
- Air dry

B-5 Analytical Methods Summary

Analytical methods for the project are summarized in Table 2. It is anticipated that sample analyses will be completed on a standard turn-around-time schedule, although some samples may require analyses on a rush turn-around schedule. Standard turn-around-time for laboratory results will be a maximum of 14 calendar days while rush turn-around-time is typically within 24 to 48 hours from receipt of the samples at the laboratory. Final data packages will be provided within 14 calendar days. The methods outlined have been selected on the basis of technical merit to achieve the data quality objectives of the project. The certified laboratory analytical methods and QC sample collection are described in the following subsections.

B-5.1 Certified Laboratory Analyses

Augured soil samples will be analyzed for the following:

- Lead per EPA 6020.
- For TCLP will Reference EPA 6020A using the extraction method EPA 1311

B-5.2 Analytical Methods and Reporting Limits

Project-specific analyte reporting limit is 400 mg/Kg. The contracted laboratory will report analytical results in milligrams per kilogram (mg/Kg) or milligrams per liter (mg/L).

B-5.3 Quality Control Samples

Quality control samples will be collected in association with environmental samples. As such, field duplicates will be collected for every 10 augured samples (10 percent). Duplicate samples will be analyzed for the same analyte as original samples (lead).

B-5.4 Holding Times

Samples shall be extracted and analyzed within the holding times presented in Table 2

B-6. Analytical Data Quality Indicators And Goals

The term "data quality" refers to the level of accuracy associated with a particular data set. The data quality associated with environmental measurement data is a function of the sampling plan rationale and procedures used to collect the samples, as well as of the analytical methods and instrumentation used in making the measurements. Each component is a potential source of bias that may affect the overall accuracy and/or precision of measurement. Data quality evaluation will be based on several indicators including precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) of the analytical methods.

Sources of accuracy that can be traced to the sampling component of environmental data collection are the sampling plan design, sample handling, sample transportation, and use of technical standard operating procedures. The important components to ensuring accuracy are proper calibration and the elimination of sources of potential contamination.

One of the largest components of total accuracy associated with environmental data collection originates from the sampling process. All sampling conducted in support of this project will incorporate review of sample location identifications and other field data prior to execution in order to minimize potential uncertainty.

Uncertainty cannot be eliminated entirely from environmental data. The amount of uncertainty that is tolerable depends on the objective of the sampling program and the intended use of the data collected.

The purpose of this project's program, as described in this project plan, is to ensure that the data collected are of known and documented quality, and are useful for the purposes for which they were collected.

Where data have elevated reporting limits, GeoMat and the EPA technical team will review the data to determine the implications for risk evaluation. This review will be conducted of preliminary data in order to assure timely recollection of samples if required. If it is determined that the elevated detection limits are acceptable to allow risk evaluation, no further sampling or analysis will be conducted. If the elevated detection limits would adversely impact risk evaluation, sampling and analytical methods will be investigated by the GeoMat and EPA technical team to determine what course of action will be required to facilitate the laboratory obtaining the appropriate detection limits. The data quality objectives for the analyses performed for this project will be assessed in terms of PARCCS. These objectives were developed based on EPA method guidelines and previous analytical and field experience. The manner in which PARCCS objectives will be evaluated is presented below.

B-6.1 Precision

Precision is a measure of the reproducibility of analyses under a given set of conditions. Precision data will be assessed from the analysis of laboratory duplicates. Precision will be expressed in terms of a relative percent difference. Precision shall be evaluated through the analysis of laboratory duplicate samples. Laboratory duplicate samples shall be performed for all inorganic and organic analyses at a rate of one in 20 (one duplicate sample for each batch up to a maximum of 20 samples). Laboratory precision goals are presented in Tables 3, 4 and 5.

Laboratory duplicate samples not meeting QC criteria shall be rerun once. Failure of different target compounds to meet QC criteria on successive runs in cases where more than one target compound is detected in concentrations 10 times the reporting limit shall constitute failure.

B-6.2 Accuracy

Accuracy is the nearness of a result or the mean of a set of results to the true value. Accuracy will be assessed through the analysis of laboratory control sample/laboratory control duplicate. The results are expressed as a percent recovery. Laboratory accuracy goals are presented in Tables 3, 4, and 5.

B-6.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Representativeness is a qualitative parameter that relates to the proper design of the sampling program. The representativeness criterion is best satisfied by making certain that sampling locations are selected properly and a sufficient number of samples are collected.

Appropriate sampling techniques and the rationale used to select sampling locations, as described in this project plan, will generate representative data for this project.

B-6.4 Completeness and Comparability

The comparability criterion is a qualitative characteristic that is an expression of the confidence with which one data set can be compared to another. Comparability is concerned with whether the field sampling techniques, analytical procedures, and concentration units of one data set can be compared with another. Data comparability will be achieved at the laboratory by using standard analytical methods and standard units of measurement, as specified in the methods.

Completeness is defined as the percentage of valid data relative to the total number of tests conducted. Valid data are comprised of those data that meet all of the acceptance criteria. The completeness goal for this project for all QC parameters, except holding times, will be 90 percent. The project goal for holding times will be 100 percent. Completeness shall be calculated by dividing the number of complete sample results by the total number of sample analyses listed in the sampling plan. Based on the severity of percent incompleteness and the impact of any incomplete data, GeoMat will discuss potential re-sampling or reanalysis to fill the data gap.

Completeness of the quality assurance and quality control program shall be evaluated qualitatively and quantitatively. The qualitative evaluation of completeness shall be determined as a function of all events contributing to the sampling event including items such as correct handling of chain of custody, etc. The quantitative description of completeness is defined as the percentage of laboratory controlled QC parameters that are acceptable. QC parameters that will be assessed for completeness will include analysis of laboratory duplicates for Relative Percent Difference (RPD), analysis of laboratory control sample/laboratory control duplicate LCS/LCDs for percent recovery, holding times, and preservation. The requirement for the quantitative assessment of completeness shall be 90 percent. The goal for holding times will be 100 percent of the samples analyzed within appropriate holding times. The requirement for holding times will be guided by the analytical holding times specified by EPA 6020 or other guidance documents specified in this plan.

B-6.5 Sensitivity

Sensitivity goals are the laboratory reporting limits for the analytical method. Laboratory reporting limits are presented in Tables 3, 4 and 5.

B-7 Data Reporting

Once the analytical data have been reviewed by the laboratory, the following information will be provided in each data package and issued to the GeoMat technical manager in a paginated report for each sample delivery group.

- For each analytical method, the laboratory shall report all analytes as a detected concentration or as less than the reporting limits. All samples with out of control spike recoveries being attributed to matrix interference will be designated as such. Dilution factors, date of digestion, date of analysis, and method detection limits shall be reported for each analyte and method.

- Reports of method blanks shall include all analytes for each analytical method. Analytical results for each sample should be clearly associated with a particular method blank. Any detected concentration found in method blanks shall be reported. Reports of concentrations below the practical quantitation limits are necessary to evaluate low-level determinations of target compounds in samples.

- Results for laboratory duplicates shall be reported with Relative Percent Difference (RPD) limits for duplicate analyses.

- Laboratory control sample/laboratory control duplicate (LCS/LCD) results shall be reported with control limits for laboratory control sample/laboratory control duplicate (LCS/LCD) analyses. Analytical results for each sample should be clearly associated with a particular laboratory control sample/laboratory control duplicate (LCS/LCD).

- Results of initial and continuing calibration for all analyses shall be included in the data package. Calibration verification standard and blank are analyzed at the beginning of the analysis and after every tenth sample. The concentrations of the standards used for analysis and the date and time of analysis must be included. Daily calibration information shall be linked to sample analyses by summary or by daily injection or analysis logs.

The contract laboratory shall prepare a summary of all samples with detected concentrations of target compounds indexed by method and by sample identification.

The comprehensive certificate of analysis shall contain a narrative section identifying samples not meeting QC criteria and any other out of control condition. The narrative shall describe the corrective action taken. If "matrix effects" data qualifiers are described as a cause for out of control recoveries, a subsection of the narrative shall present a detailed justification for this assertion to include a summary of all relevant quality control data.

The data package shall be prepared at the conclusion of the sampling and analytical work. If requested, draft analytical results and preliminary QC data only shall be submitted to GeoMat as soon as they are available. Draft analyses results do not have to satisfy all of the requirements of this section, but should contain basic QC information such as method blank results.

The QC information provided will be used by GeoMat project staff to evaluate the quality of the data. The results of the GeoMat evaluation of the data and data validation will be summarized and included in the appropriate technical report.

SECTION "C" DATA VALIDATION AND USABILITY

Data validation is the systematic process for reviewing a set of data against pre-established criteria to determine the quality of the data. The laboratory will review their data for nonconformance and consistency before submittal to GeoMat. Upon receipt of the analytical data package from E.S. Babcock and Son, Inc., GeoMat project personnel will check the following items:

- Data package includes all requested deliverables
- Samples were analyzed as requested
- Sample holding times were met
- QC sample results were within established control limits
- Appropriate detection limits we
- Preservation met
- Chain-of-Custody maintained
- Sample integrity maintained
- Calibration criteria met
- Blank sample results reported correctly

A systematic effort will be made to identify any outliers and/or errors prior to the reporting of the data to EPA. Outliers (data values that are significantly different from the population) can result from improper sampling or analytical methodology, matrix interference, errors in data transcription, and real but extreme changes in analytical parameters. Outliers that result from errors found during data validation will be identified. Outliers that cannot be attributed to analytical, calculation or transcription errors will be retained in the database for further evaluation. Final data will be reviewed in accordance with the project specific criteria specified in this project plan and the method specific criteria stated in the analytical method. Results from the data review will be included in the appropriate technical report and submitted to EPA.

DeLORME

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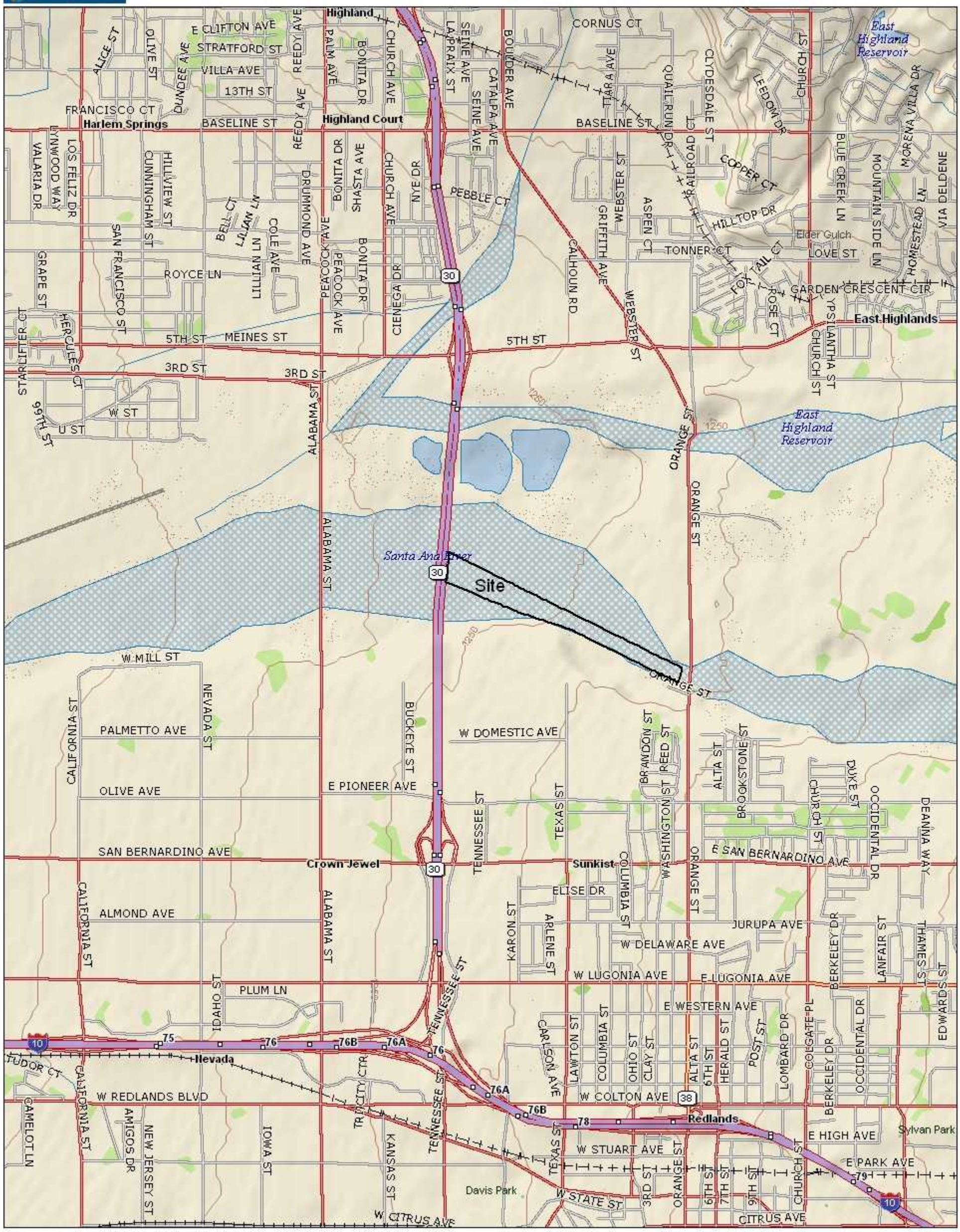

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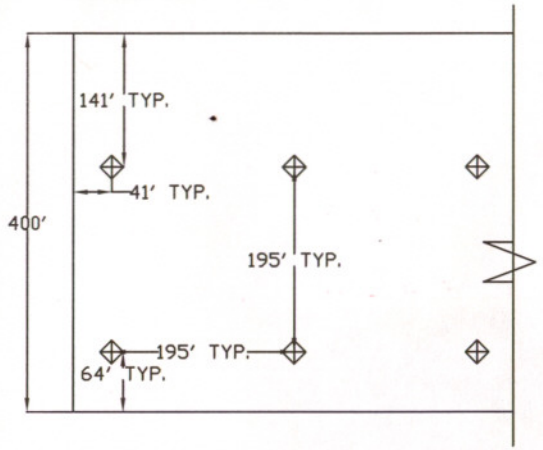
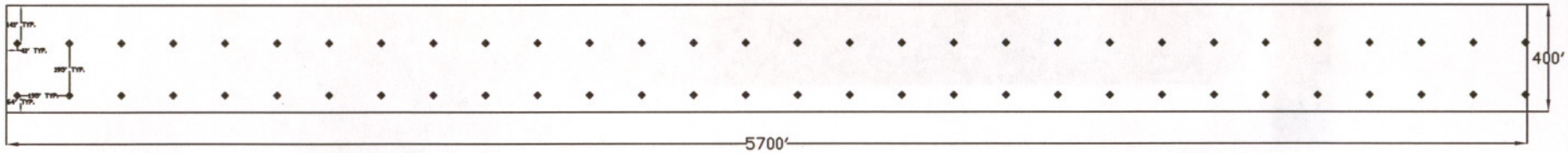
Data Zoom 12-5

Redlands

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED

Detail: A





Note: Distances are rounded to the nearest foot
Points chosen by VSP software

geomat

Soil Sampling Plan

Redlands Shooting Range

2125 N. Orange St., Redlands CA, 92374

SIZE	FSCM NO.	DWG NO.	REV
		Plate 1	

SCALE | SHEET

GeoMat Testing Laboratories August 10, 2011 Redlands Sampling

Table 1 Data Quality Objectives

Step 1 Statement of the Problem	Step 2 Identification of Decisions	Step 3 Identify Inputs to Decisions	Step 4 Definition of Study Boundaries	Step 5 Decisions Rules	Step 6 Limits on Decision Errors	Step 7 Sampling Design
The site contains soil containing lead of unknown levels	The primary decision associated with the project is to collect data to confirm the extent of the contamination. The following decision must be made: • The horizontal and vertical extent of contaminated soil containing lead	The following input will be used to make the decisions in Step 2: • Analytical results from sampling and analysis. • Standard analytical methods published by the EPA, State regulatory authorities, etc. are available for lead testing to make remedial action decisions. • Analytical services of certified laboratory will be used to perform the sample analysis.	Lead pellet drop zone is northerly of the earthen berm (currently used as target range). The estimated distance is 400 feet toward the north. This is based on 600 feet range of fired shots. The length in the downstream direction of the study area was discussed with Mr. Robert Wise of the EPA and decided on including the study up to Highway 30 overpass bridge. This distance was measured at approximately 5700 lineal feet. Hence the total area of this investigation is 400 feet wide and 5700 feet in length.	The following "if….then" statement will serve as the decision rule for the project: "If analytical results indicate that soil samples contain concentrations of lead exceeding the limit then area would require remediation and future action will be discussed with EPA."	The following limits on decision error will be implemented: Laboratory quality control limits consistent with project objectives will be implemented as listed in Section B5	Biased judgmental soil sampling will be used to document concentrations of the analysis from excavations. Samples will be taken from locations within the site per attached plan. The samples will be collected from 4 feet below ground surface. Refer to Plate 1, Sample Location Map.

Source: Fictitious data, for illustration purposes only

Table 2 Summary of Sample Collection and Analysis

Type	Analyte	Analytical Method	No. of Samples	Sample Container	Preservative	Holding Time	Sample Volume
Soil Sample	Lead	EPA 6020	100	Glass Jar	4° C	6 months	200ml

E.S. Babcock & Sons, Inc.

8/10/2011

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
EPA 6020 -- Metals and Metalloids; EPA SW846 Series inSolid								
Preservation: NA								
Container: 8 oz. jar			**Amount Required:** 1g/50g			**Hold Time:** 180 days		
Lead	0.29	10 mg/kg		20	71.5 - 125	20	72.6 - 123	

Table 3

E.S. Babcock & Sons, Inc.

8/10/2011

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
EPA 6020A -- California Waste Extraction Test (Title 22 sec. 66261 Apx II); Inorganics inSolid								
Preservation: Store cool at 4°C; Add HNO3 to pH<2 after extraction								
Container: 8 oz. jar				**Amount Required:** 50g/200 g			**Hold Time:** 180 days	
Lead	0.0039	0.50 mg/L			72.9 - 123	20	77 - 117	

Table 4

E.S. Babcock & Sons, Inc.

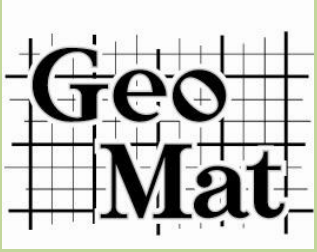
8/10/2011

Analytical Method Information

Analyte	MDL	Reporting Limit	Surrogate %R	Duplicate RPD	Matrix Spike %R	Matrix Spike RPD	Blank Spike / LCS %R	Blank Spike / LCS RPD
EPA 6020A -- Toxicity Characteristic Leaching Procedure (EPA Method 1311); Metals inSolid								
Preservation: Store cool at 4°C; Add HNO3 to pH<2 after extraction								
Container: 8 oz. jar				**Amount Required:** 100 g/500g			**Hold Time:** 180 days	
Lead	0.00097	0.50 mg/L			79 - 121	20	78.8 - 121	

Table 5

Appendix A



Technical Standard Operating Procedures

Surface and Shallow Subsurface Sampling

August 10, 2011
Project No. 11059-01

Prepared by:

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide a standardized method for surface soil sampling, to be used by employees of USEPA Region 8, or contractors and subcontractors supporting USEPA Region 8 projects and tasks. This SOP describes the equipment and operations used for sampling surface soils in areas which will produce data that can be used to support risk evaluations. Deviations from the procedures outlined in this document must be approved by the USEPA Region 8 Remedial Project Manager, Regional Toxicologist or On-Scene Coordinator prior to initiation of the sampling activity.

2.0 RESPONSIBILITIES

The Field Project Manager (FPM) is responsible for overseeing the soil sampling activities. The FPM is also responsible for checking all work performed and verifying that the work satisfies the specific tasks outlined by this SOP and the Project Plan. It is the responsibility of the FPM to communicate with the Field Personnel regarding specific collection objectives and anticipated situations that require any deviation from the Project Plan. It is also the responsibility of the FPM to communicate the need for any deviations from the Project Plan with the appropriate agency or project team managers.

Field personnel performing surface soil sampling are responsible for adhering to the applicable tasks outlined in this procedure while collecting samples. The field personnel should have limited discretion with regard to collection procedures, but should exercise judgment regarding the exact location of sample collection, within the boundaries outlined by the FPM.

3. 0 EQUIPMENT

- Thin-walled tube sampler - thin-walled metal or teflon tube (also called a Modified California ring/tube) used to recover relatively undisturbed soil samples. Augers are available at various depths, and soil cores may range in length from 1 inch to 6 inches.

- Soil augers - Various models of soil augers are acceptable and selection of the specific brand and make of tool will be recommended by the contractor implementing the field work. Augers must be made of stainless steel, and should be capable of retrieving a cylindrical plug of soil 2 inches in diameter and at least 2 inches deep or bulk samples. In all cases the procedures recommended by the manufacturers should be followed with regard to use of the auger.

- Trowels - for extruding the soil sample from the auger. For samples that will be analyzed for trace metals, avoid the use of chrome plated trowels, as they may interfere with the analysis.

- Collection containers - as specified in the Project Plan.

- Gloves - for personal protection and to prevent cross-contamination of samples. May be plastic or latex; should be disposable and powderless.

- Field clothing and Personal Protective Equipment - as specified in the Health and Safety Plan.

- Sampling flags - used for identifying soil sampling locations.

- Field notebook - a bound book used to record progress of sampling effort and record any problems and field observations during sampling.

- Three-ring binder book- to store necessary forms used to record and track samples collected at the site. Binders will contain the Field Data Sheet, Site Diagram, and sample labels. Example forms are provided in the Sample Documentation SOP.

- Permanent marking pen - used to identify sample containers and for documentation of field logbooks and data sheets.

- Measuring tape or pocket ruler - used to measure the length of soil core in the soil coring device.

- Trash Bag - used to dispose of gloves and any other non-hazardous waste generated during sampling.

4.0 SURFACE SOIL COLLECTION

4.1. Collection of soil cores for non-volatile chemical analysis

Surface soil will be collected from each of the areas identified in the Project Plan. Samples will be collected with an auger and Thin Wall Tube Sampler. This system consists of a “T” shaped handle auger fitted with a sample tube capable of collecting soil cores that are at least 6 inches in depth. The sample collection tube must be constructed of teflon, or other non-reactive material, to avoid contamination of the soil sample.

A new pair of plastic gloves are to be worn at each boring location. Each soil boring location must be recorded on the site diagram prior to collecting the sample. Clear the area to be sampled of any surface debris (e.g., twigs, rocks, litter) that can be easily removed by hand. After the sampling tube is fitted to the auger, push the auger into the soil by a continuous and rapid motion, without impacting or twisting. In no case shall the tube be pushed further than 6 inches.

After reaching the desired depth, slowly and carefully remove the auger from the boring. Measure the length of the core and record on the Field Data Sheet. Carefully remove the soil from the auger, and place directly into the sample container. Affix one sample ID label to the sample container, and one to the Field Data Sheet.

Decontaminate sample equipment as described in Section 8.0.

4.2. Collection of soil cores for volatile analysis

Use a new pair of disposable gloves for each sample. Record the sample location on the site diagram. Repeat the same procedure as described in Section 4.1, placing the soil core directly into a sample container that is designed for volatile organic analysis. Affix one sample ID label to the sample container, and one to the Field Data Sheet.

If sampling equipment is to be re-used, follow the decontamination procedures outlined in Section 8.0 before collecting the next sample.

4.3. Collection of surface soil samples using a soil auger

Place the soil coring tool on the ground and position it vertically. Holding the tool handle with both hands, apply pressure sufficient to drive the tool approximately 2 inches into the ground while applying a slight twisting force to the coring tool. Remove the tool by pulling up on the handle while simultaneously applying a twisting force. If the sample was retrieved successfully, a plug of soil approximately two inches long should have been removed with the coring tool.

Hold the soil coring tool horizontally or place it on the ground. Using a clean spatula or knife, remove the soil collected at depth greater than two inches from the end of the sampling tool. Use a trowel to extrude the soil from the auger, pushing the two-inch soil plug from the coring tool so that it falls directly into the container.

If sampling equipment is to be re-used, follow the decontamination procedures outlined in Section 8.0 before collecting the next sample.

Care should be taken to avoid tracking soil from one area to another. As samples are taken sequentially, care should also be taken not to contaminate an area yet to be sampled with the residue of the sample that is currently being taken. In general one should move in a single direction through the sampling area. If an area is known or suspected of having a higher concentration of contaminants, all other considerations being equal, it should be sampled last to prevent cross contamination.

Decontaminate equipment as described in Section 8.0.

5.0 SAMPLE CONTAINERS AND LABELING

Following the procedures outlined in Section 4.0, soil borings will be collected directly into sample containers, and shipped to the participating laboratory. For each soil core, two sample identification labels are required. One label is placed on the Field Data Sheet and the other label is affixed to the sample container.

Sample labeling will occur as prescribed below:

1) Place a pre-printed label onto the sample container (See Project Plan).
2) Place a pre-printed label onto the Field Data Sheet.
3) This procedure will be repeated for each soil core collected using clean sample containers and unique sample ID numbers.

Do not allow samples to freeze; place all samples directly onto wet ice (4°C). Ship samples under chain-of-custody, protected with suitable resilient packing material to reduce shock, vibration, and disturbance.

6.0 SITE CLEAN-UP

All soil boring holes will be back-filled with site soil or clean topsoil. If any rinse water used for sample decontamination is generated in the course of sample collection, it must be disposed of as specified in the Project Plan. Wherever possible, soil should be replaced in the sampling hole.

All marker flags (if reused) should be decontaminated by wiping off with towels and/or baby wipes before re-use.

Disposable PPE and other non-hazardous waste generated during sampling activities will be placed in a trash bag and taken to a waste receptacle at the field office to prevent disturbance by animals and dispersion by wind. These wastes will be disposed along with trash at a municipal landfill.

Soils and decontamination rinsate waste generated during sampling activities will be placed in DOT-compliant drums in accordance with 40 CFR 265 Part I. All non-hazardous waste will be disposed of in municipal waste bins.

7.0 RECORD KEEPING AND QUALITY CONTROL

Each field crew will carry a three-ring binder book that contains the riparian soil data sheet, site diagram, and sample labels. In addition, a field notebook should be maintained by each individual or team that is collecting samples, as described in the Project Plan. Each soil sample location must be recorded on the site diagram. Each sample should have an ID number affixed to the sample container, and the duplicate label must be affixed to the data sheet. Deviations from this sampling plan should be noted in the field notebook, as necessary.

For each location, the notebook information must include:

a. date
b. time
c. personnel
d. weather conditions
e. sample identification numbers that were used
f. descriptions of any deviations to the Project Plan and the reason for the deviation.

Samples taken from soils with visible staining or other indications of non-homogeneous conditions should also be noted. Field personnel will collect the proper type and quantity of quality control samples as prescribed in the Project Plan.

8.0 DECONTAMINATION

Because decontamination procedures are time consuming, having a quantity of sampling tools sufficient to require decontamination at a maximum of once per day is recommended. All sampling equipment must be decontaminated prior to reuse as prescribed in the Project Plan.

9.0 GLOSSARY

Project Plan - A written document that spells out the detailed site-specific procedures to be followed by the FPM and the field personnel. In this case, the Project plan consists of the Phase 3 Sampling and Analysis Plan.

10.0 REFERENCES

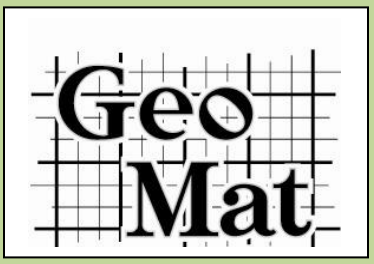
Mason, B.J. 1983. Preparation of soil sampling protocol: Techniques and strategies. EPA - 600/4-83-020.

USEPA. 1984. Characterization of hazardous waste sites - a methods manual: vol. 2. EPA-600/4-84- 076.

American Society for Testing and Materials, 1985. Thin-Walled Tube Sampling of Soils. Method D1587-83, Annual Book of Standards.

American Society for Testing and Materials, 1995. Standard Practice for Field Collection of Soil Samples for Lead Determination by Atomic Spectrometery Techniques, ASTM Designation: E 1727 - 95, October 1995, 3 p.

Appendix B



Effective July 1, 2011
(This document supersedes that which was effective October 30, 2010.)

QUALITY ASSURANCE MANUAL

Of

BABCOCK LABORATORIES, INC.
DBA
EDWARD S. BABCOCK AND SONS, INC
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Approvals:

Allison Mackenzie
CEO & CFO

Lawrence J. Chrystal
Laboratory Technical Director

Stacey Fry
Quality Assurance Manager

Susann K. Thomas
Laboratory Director of Operations

Carol Kase
Microbiology Department Manager

In addition to the Project Managers, the above are approved signatories for E.S. Babcock & Sons, Inc. E.S. Babcock & Sons, Inc. has no parent corporation or subsidiaries and is located at 6100 and 6110 Quail Valley Court, Riverside, CA 92507.

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1.0 INTRODUCTION

1.1 This document outlines the Quality Assurance procedures and management system implemented by Babcock Laboratories, Inc., a privately owned environmental laboratory involved primarily in the testing of drinking water, wastewater, soils, and other matrices including food and bottled beverages. (http://www.babcocklabs.com). This document describes the framework by which the laboratory establishes and maintains a documented quality system appropriate to the type, range, and volume of environmental and food/beverage testing activities it undertakes. This document outlines the laboratory's policies and procedures established in order to meet the requirements set by both the National Environmental Laboratory Accreditation Conference (NELAC, http://www.nelac-institute.org) for National Environmental Laboratory Accreditation Program (NELAP) accreditation facilitated by The NELAP Institute (TNI) and by ISO/IEC 17025:2005 Standard "General requirements for the competence of testing and calibration laboratories". See Appendix A for copies of the laboratory's certification. Other documents and procedures will be referenced and should be consulted for specific details. The quality and management system is maintained to provide accurate and dependable data for the laboratory's clients. It is the responsibility of each employee to be familiar with and implement the quality control practices of the laboratory. Additionally, management is responsible for maintaining Quality Assurance (QA) in all aspects of the operation.

2.0 COMPANY VISION AND MISSION STATEMENT

2.1 Company Vision: *Creating a positive environment where laboratory professionals proudly deliver unparalleled services.*

2.2 Mission: *The goal of Edward S. Babcock & Sons, Inc. is to produce the highest quality, most reliable environmental services and analytical data.*

3.0 OBJECTIVES

3.1 To achieve this goal the corporate officers, board of directors and managers of the company are committed to these objectives:

3.1.1 To provide professional service to clients and the community, drawing on the many years of experience in the analytical testing industry.

3.1.2 To produce scientifically valid and legally defensible data.

3.1.3 To promote ethical standards and professional integrity within our organization and the environmental community.

3.1.4 To attract and retain the best, well educated, and properly trained staff possible.

3.1.5 To promote growth of the company in a fiscally responsible and profitable manner.

4.0 FLOW OF RESPONSIBILITY:

4.1 The flow of responsibility within the laboratory follows the organizational chart. See Appendix C for Organization Charts and Appendix D for Resumes of Key Personnel.

4.1.1 The CEO is responsible for the business functions of the company.

4.1.2 The CEO oversees the office and the generation of all final reports.

4.1.3 The Laboratory Director of Operations is in control of the operations of the laboratory. The Laboratory Technical Director is in control of instrumentation, methodology and technical areas of the laboratory.

4.1.4 The QA Manager has access to the CEO and Laboratory Directors and is responsible for ensuring lab wide compliance with the NELAP standard (see NELAC Quality System Information in Appendix I) and the ISO 17025 standard.

4.1.5 The QA Auditor and QA Assistant help the QA Manager with routine analytical audits and Quality Control paper work.

4.1.6 The Project Managers are responsible for ensuring that client needs are met with respect to QC requirements and final reporting. Project Managers are also approved signatories for their assigned client reports.

4.1.7 The Inorganic Department Manager oversees the Inorganic Department Supervisor and the Metal's Department.

4.1.8 The Supervisors and Managers are accountable for the smooth operation of their sections, meeting holding time deadlines, and troubleshooting problems. They ensure the competence of all who operate specific equipment, perform analytical tests, evaluate results, and sign test reports.

4.1.9 The chemists and technicians are held responsible for following prescribed protocols in the performance of their assigned analyses, and keeping their managers apprised of any difficulties that could affect the accuracy of results or the smooth operation of the laboratory.

4.1.10 Where contracted and additional technical and key support personnel are used, the laboratory ensures that such personnel are supervised and competent and that they work in accordance with the laboratory's quality system.

4.2 The CEO is named as Deputy Laboratory Technical or Operations Director and fulfills that responsibility when one or both of the Laboratory Directors are absent. See Appendix E for a list of specific duties. If this absence exceeds 65 consecutive calendar days, CADHS-NELAP will be notified in writing. The Laboratory Director(s) are named as Deputy QA Officers and fulfill that responsibility when the QA Manager is absent.

4.3 Job descriptions for several key positions are attached to this document in Appendix E. Job descriptions for all positions are maintained in the personnel files.

4.4 The QA Department includes the QA Manager and designee(s) (i.e. QA Auditor and QA Assistant) performing tasks under the direction of the QA Manager. The members of the QA Department may also be referred to as QA Officers. The QA Office is the location of the QA Manager's desks and is where they maintain their files.

5.0 CONTRACT REVIEW

5.1 The laboratory has established procedures for the review of requests, tenders and contracts. Before the initiation of any analytical testing program, a review of the request is required. Records of reviews are maintained for ongoing work, along with any pertinent information regarding client's requirements. An oral agreement or a written contract may be entered into to provide the client with testing services. Any differences between the request or tender and the contract shall be resolved before work is commenced. The client is to be contacted if laboratory accreditation is suspended, revoked, or voluntarily withdrawn. For more information on contract review, refer to the Review of Contracts and Tenders SOP (A13).

5.2 Laboratory Capacity

5.2.1 It is the responsibility of the Laboratory Director(s) to ensure adequate capacity for all new projects prior to commencing work. The system used to determine laboratory capacity is based on the time taken to analyze a batch of samples for a given analyte, the number of analysts and labor hours available, and the equipment at hand. Each test is monitored for frequency of request on a weekly basis. When new work is contemplated, workloads are

reviewed to determine what number of samples can be added while remaining within the laboratory capacity to perform the work.

6.0 CONFIDENTIALITY

6.1 **Laboratory reports** and accompanying documents contain confidential information intended for use by the individual or entity requesting and purchasing the analytical services. Except when required by law, no information relating to a report is released to another person or party without permission from the paying client.

6.2 Laboratory documents containing client's information are to be handled and disposed of in a discrete manner.

6.3 Permission to release information may be given by **telephone or in writing**. Documentation of consent, including the name of the person and the date/time of consent, is recorded in the client file.

6.4 **Faxes** clearly identify the intended recipient. The fax coversheet utilized by Babcock Laboratories contains a statement at the bottom of the sheet stating that the contents of the fax are confidential and intended only for the recipient. If the laboratory is familiar with a particular client, and there is agreement between the lab and the client, the cover letter may be omitted for brevity purposes.

6.5 Results transmitted via **E-mail or EDD** are also accompanied by a confidentiality statement.

6.6 Client results may be accessed via the **Internet**. These results are password protected and hosted by a server separate from the laboratory's main server.

6.7 Employees are informed of these policies during new employee orientation.

7.0 EXCEPTIONAL CIRCUMSTANCES

7.1 In the event that it is necessary to deviate from a documented policy, procedure or specification, several steps must be taken for approval of the exception. The QA Manager and Laboratory Directors meet to discuss and research the proposed exception. When circumstances are such that the QA Manager and Lab Directors agree that permission to deviate from policy, procedure or specification is warranted, the following steps must be taken.

7.1.1 Where applicable, the client is contacted for approval of the proposed change in procedure and verbal or written approval is requested and receipt verified.

7.1.2 The agreed upon change in policy, procedure, or specification is documented and kept in the project file.

7.1.3 Copies of the change are attached to the analytical records, where applicable.

7.1.4 Copies of the change are attached to the review reports for any analyses directly related to the change.

7.1.5 Copies of the change are filed in the client report file.

8.0 COMPLAINTS

8.1 Client concerns regarding any aspect of laboratory services are directed to the Client Services Manager, the Vice President of Sales and Marketing, or the Project Managers. Questions or concerns from representatives of regulatory agencies are directed to the Laboratory Directors or a manager designated as a Deputy Laboratory Director. For any question or concern, the problem is first researched and the circumstances surrounding the incident are ascertained.

8.2 Where analytical results are at issue, the data is re-verified by the QA Manager or Department Supervisor or Manager. If the sample is still available a re-analysis may be requested to verify the original data. Where an error is identified, an amended report is issued.

8.3 The laboratory will gladly afford the client cooperation to clarify any client request to include laboratory visits and QC and PT data inspections.

8.4 If the investigation of any question raises doubt about compliance with the established laboratory policies, procedures or the quality of calibrations or test, the area of concern is audited in accordance with the audit section of this document. For more information on follow up documentation, refer to the Quality Control Follow-Up Forms SOP (Q24).

9.0 RECORD KEEPING

9.1 The laboratory information management system (LIMS) maintains records of Quality Control (QC) performance data and client samples data. All electronic and hard copy records are readily retrievable. For more information on data records, refer to the Records Management SOP (A02). It is the responsibility of the QA Manager or her designees to periodically review LIMS-generated records of QC performance data and to update acceptance criteria, as needed. For more information on the QC data review, refer to the Statistical Evaluation of Quality Control Data SOP (Q03).

9.2 Analytical run records are maintained as part of batch documentation for a particular analysis. An analytical run (listed in the LIMS as a "Batch") can contain calibration standards, blanks, lab control samples, replicate analyses, matrix spikes, matrix spike duplicates, and sample data analyzed as a group and may contain one or more analytical batches. Raw data contains the following information:

9.2.1 Sample preparation.

9.2.2 pH observations including preservation confirmation (unless documented in splitting)

9.2.3 Sample matrix on bench sheet.

9.2.4 Standard origin (See SOP Q05 section 4.0 for reagent origin.)

9.2.5 Method of analysis.

9.2.6 Initials of analysts involved with the sample clearly indicating: "prepared by," "analyzed by" or "reviewed by".

9.2.7 Date and time of analysis.

9.2.8 Instrument i.d.

9.2.9 QC results and acceptance criteria.

9.3 All records are written in ink. Analysts are instructed to write legibly.

10.0 RECORDS MANAGEMENT

10.1 All hard copy and electronic records are stored on-site, or at an independent archive facility, for at least 5 years. After the archive period, the records are destroyed by a reputable records archiving and disposal company. Records maintained for at least five years include:

10.1.1 LIMS electronic files.

10.1.2 Raw analytical data files, hard copy and electronic.

10.1.3 QC data files including standard verification, control charts and corrective action reports.

10.1.4 Analytical data review reports

10.1.5 Client files including all final reports, Chain of Custody forms, Analysis Request Forms, and other correspondence.

10.1.6 Personnel files including:

10.1.6.1 Personnel qualifications, experience, and training records.

10.1.6.2 Initial demonstration of capability (IDOC) and demonstration of continuing proficiency (DOCP) for each analyst or analytical work group.

10.1.6.3 A log of names, initials, and signatures for all individuals who are responsible for signing or initialing any laboratory records.

10.1.6.4 A record of Standard Operating Procedure (SOP) review and comprehension.

10.1.7 Business files including accounts payable, accounts receivable and payroll data.

10.2 Records are stored according to category in standard cardboard file boxes labeled with the category of records, date range, and descriptive information. A unique container number further identifies containers stored off-site. An access log is maintained for both on-site and off-site record retrieval.

10.3 There is a document control system indicating the time period during which a procedure, manual, or document is in effect. For more information regarding record management, refer to the Records Management SOP (A02) and the SOP Modification Policy (Q23).

11.0 TEST METHODS UTILIZED BY THE LABORATORY

11.1 ESB uses appropriate test methods and procedures for all tests and related activities within its responsibility (including sample collection, sample handling, transport and storage, sample preparation, and sample analysis). The methods and procedures are consistent with the accuracy required, and with any standard specifications relevant to the calibrations or tests concerned.

11.1.1 The laboratory uses the most appropriate valid edition of a standard or method.

11.1.2 When the use of a specific test method for a sample analysis is mandated or requested, only the specified method is used.

11.1.3 When similar tests are combined in an analytical run, the most stringent method requirements are followed.

11.1.4 Where test methods are employed in a Performance Based Measurement System approach, the methods are fully documented and validated, and are available to the client and other recipients of the relevant reports.

11.2 Test Methods currently used by Babcock Laboratories may be found in *SW-846, Test Methods for Evaluating Solid Wastes Physical/Chemical Methods*, 3rd edition Update III 1996, *Methods for the Determination of Inorganic Substances in Environmental Samples*; EPA 600-R-93/100; *Methods for the Determination of Metals in Environmental Samples*; EPA 600-R-93/100; *Methods for the Determination of Metals in Environmental Samples, Supplement I*, EPA-600/R-95/111, EPA 500 and 600 series methods included or referenced in the Federal Register; and *Standard Methods for the Examination of Water and Wastewater*, 18th, 19th, and 20th editions, APHA/AWWA/WEF; Bacteriological Analytical Manual (BAM), 8th edition; Compendium of Methods of the Microbiological Examination of Foods (CMMEF), 4th edition; AOAC Official Methods of Analysis (OMA), 18th edition, or other approved or accepted methods.

12.0 HOUSEKEEPING AND SAFETY

12.1 Each analyst is responsible for keeping his or her work areas as neat and clean as possible. Each employee is warned of potential safety problems and is advised to be familiar with the following:

12.1.1 An eye wash station is available in each of the labs.

12.1.2 A drench-type safety shower is available in each of the prep labs and in the inorganic, bacteriology, semi-volatile, and volatile labs.

12.1.3 Fire extinguishers are placed at several locations throughout the laboratory. They are easily found by signs that display their location. Analysts should be aware of the fire extinguishers located in their work areas. All fire extinguishers are serviced annually by contract with an outside company.

12.1.4 Chemical spill kits are centrally located and are available for solvents, mercury, caustics and acids.

12.1.5 First Aid kits are located in every lab. A fire blanket is located in each of the prep labs.

12.1.6 Flammable solvents are stored in an explosion proof cabinet with appropriate venting or below the hoods.

12.1.7 Evacuation plans are posted at several locations in the laboratory.

12.1.8 There is a Material Safety Data Sheet (MSDS) Library centrally located and readily accessible to all personnel in the main hallway of 6100 Quail Valley Court.

12.2 Copies of the laboratory Emergency Plans are accessible to all personnel. Copies are located in the study as well as on the NAS Server. These include a *Business Emergency Plan (BEP)*, *Chemical Hygiene Plan (CHP)*, *Fire Prevention Plan (FPP)*, and *Injury and Illness Prevention Plan (IIPP)*.

13.0 SAMPLING (See Appendix H for Sampling Procedure References)

13.1 Each member of our Field Department has a detailed knowledge of proper sampling techniques, sample handling procedures, and the criteria for sample acceptability. Field Department employees are trained in the proper safety requirements and precautionary measures to be used in field activities and have read and agreed to follow Field Sampling SOP (F02). The Field Department employees are advised to discuss with the on-site supervisor (if applicable) all steps necessary in obtaining the most representative sample possible – especially in unusual sampling situations.

The Field Department and Log-in employees have each read and agreed to follow the Sample Acceptability SOP (A08). Samples are collected only in approved containers. The Field Department is currently not responsible for the sample collection of food and bottled beverage products, in these instances samples are provided by the client. Sample approval is based on the following requirements:

13.1.1 **Containers must be compatible with the sample and contain an adequate volume of sample.** The sample must not cause the container to corrode and the container must not contaminate the sample. It must be of sufficient volume to hold enough sample for the required analyses – if not, multiple containers may be used, if needed.

13.1.2 **Containers must be made of approved materials.** For most uses, containers may be made of LPE plastic. Soda glass or borosilicate with Teflon is used for organic sampling. Plastic zip-lock bags or Mason jars are acceptable for many types of solid samples. For source gas emissions, tedlar bags, canisters, and absorbent traps are commonly used.

13.1.3 **Containers must be sterile for bacterial analysis.** Sterilized containers and lids are utilized for all bacterial analyses. A capacity of at least 100 ml is required. For bacteriological samples, we recommend sealing the containers in a zip-closure bag after collection for transport to the lab. Food and bottled beverage samples are submitted in their sealed product containers as provided by the client.

13.2 The next section discusses other criteria used to determine sample acceptability including sample preservation, sample temperature, sample holding time, and condition of sample seal or evidence tape (if present).

13.3 The preservation and storage of samples varies according to the analyses to be performed. Proper preservation and storage may be found in *SW-846, Test Methods for Evaluating Solid Wastes Physical/Chemical Methods,* 3rd edition Update III 1996, in the *Handbook for Sampling and Sample Preservation of Water and Wastewater,* Sept 1982 EPA-600/4-82-029, 40CFR136 and 40CFR141.

13.4 For more information regarding sample collection, refer to the Field Sampling SOP (F02). For sample containers, preservation and holding times refer to Appendix L – SOP (Q14).

14.0 SAMPLE IDENTIFICATION, CUSTODY, AND TRACKING

14.1 All written records are in indelible ink. For more information regarding sample acceptability, receiving and log-in, refer to the Sample Acceptability SOP (A08) and the Sample Receiving/Log-in SOP (A03).

14.2 Sample Identification

The samples are labeled in the field. The identification on the label includes the following. The information must be presented in such a way that the sample is uniquely identified and includes the following:

14.2.1 Identification of the sample.

14.2.2 The sampler's name.

14.2.3 The date the sample was taken.

14.2.4 The time (24-hour clock when possible) the sample was taken.

14.2.5 The client's name.

14.2.6 Significant information regarding the analysis (e.g. tests to be performed, temperature upon sampling, chlorine residual,

preservation, if the sample is a composite or grab, miscellaneous comments, etc.)

14.3 Sample seals may be used to indicate possible tampering with the sample from the time of collection until the sample arrives at the laboratory – this is especially important for samples that may be used for litigation purposes and are delivered to the laboratory by the client or a third party.

14.4 Chain of Custody

14.4.1 When necessary, a Chain of Custody form is filled out. A Chain of Custody is required whenever the potential exists that the sample may be used for litigation. An example form is included in Appendix K. This form contains all of the above information included on the label and also "Relinquished by" and "Received by" blocks for the name(s) of the person(s) who submit or release the sample and the name(s) of the person(s) who receive the sample along with the date(s) and time(s) that the custody of the sample changes hands. The Chain of Custody also includes information relating to sample acceptability.

14.4.2 Information stored in LIMS serves as an internal Chain of Custody documenting sample use within the laboratory (section 14.7). If for litigation purposes a client requires the sample to be accessed only thru a custody officer, a form is available that tracks sample custody within the laboratory. When not in use the sample is kept in a locked refrigerator. For more information on litigation samples, refer to the Legal/Evidentiary Custody for Litigation Samples SOP (A01).

14.5 Sample Receipt Form

Whenever a Chain of Custody is not submitted with a sample, a Sample Receipt Form is filled out to document sample acceptability. This form lists the

sample description and E.S. Babcock's laboratory number to unequivocally tie the form to the field sample. An example form is included in Appendix K.

14.6 Field Records

Field technicians maintain a logbook to document all of their sampling activities. This logbook contains pertinent information regarding collection of samples, including:

14.6.1 Name of contact

14.6.2 Location of sampling point

14.6.3 Date and time (24-hour clock) of collection

14.6.4 Field measurements

14.6.5 Comments

14.6.6 Any other information that is required by the Project Plan.

14.6.7 The field technician retains a copy of each Chain of Custody accompanying that day's samples.

14.7 Sample Tracking: Laboratory Information Management System

The laboratory has in place a LIMS for the tracking of all samples from the time they are logged in until the final report leaves the laboratory. At any step in the process, current information regarding the status of the sample can be obtained from the computer. The computer also keeps track of holding times and due dates.

14.8 Log-in of Samples

After the sample is collected, custody of the sample is turned over to the laboratory at the front counter. Log-in personnel verify sample acceptability – documenting acceptability on the Chain of Custody or a Sample Receipt Form. A Sample Acceptability checklist is posted in Log-in as a reminder of the criteria list. The client is contacted if any of the following occur:

14.8.1 The container is leaking or damaged.

14.8.2 The Chain of Custody seal is broken, if present.

14.8.3 The identification of the sample is not the same as that on the Chain of Custody (if the identification is not very different, the information is noted without necessarily contacting the client).

14.8.4 The sample is received past holding time (or likely to expire before the lab is able to perform the test).

14.8.5 The temperature of the sample exceeds method requirements.

14.8.6 The sterility of the sample container is questionable, if for bacteriological analysis.

14.9 The client must verbally authorize the lab to proceed with analysis if any of the above conditions are observed. This authorization is noted on the Sample Receipt Form or the Chain of Custody.

14.10 The Department Supervisor or Manager is informed if the samples are not preserved properly, incorrect containers are used, inappropriate sample size is provided, holding times have been exceeded, or any other problems occur so that corrective action, either in the lab or through the client, may be taken. Proper notation and warning is given before any sample is accepted under the conditions above.

14.11 Upon acceptance of the sample from the field technicians or directly from a client, the sample is logged-in.

14.12 Every laboratory number or SampleID number that is assigned corresponds to a specific sample. The computer generates this number. The information in the computer unequivocally links the sample to the field identification. Other information recorded in the computer includes the following:

14.12.1 The name of the person, company, or agency requesting the analysis.

14.12.2 The sample description (corresponding to the field identification).

14.12.3 The date and time (24-hour clock) the sample was taken and the identity of the sampler.

14.12.4 The date and time (24-hour clock) the sample is submitted to the laboratory and the identity of the person submitting the sample.

14.12.5 The identity of the person logging in the sample.

14.12.6 The sample matrix.

14.12.7 The type of sample container.

14.12.8 Sample preservation (see also the Bottle Preservation SOP A09).

14.12.9 If evidence tape and/or seal are present.

14.12.10 Analyses requested - Constituents.

14.12.11 Chain of Custody (Y or N).

14.12.12 If thermal preservation is required, the temperature of the sample at receipt. (If recently collected, is the sample on ice?)

14.12.13 Any other pertinent information (such as any abnormalities or departures from the condition specified in the test method, reporting limit requests, high level QC or QC review requests, contact details, sample preservation exceptions).

14.13 After Log-in, two items are generated by the LIMS:

14.13.1 A Work Order Report containing information such as Client ID, Laboratory Number, analyses requested, and date/time of receipt is printed. Chem and Bacti reports are kept sequentially in three-ring notebooks or file folders. Office staff verifies the log-in information and initial the report. The Chain of Custody/Sample Receipt Form (including any common carrier documents received) and any other paperwork submitted with the samples are kept with the Work Order Report. These documents are pulled for

inclusion with the final report when the laboratory completes the analysis.

14.13.2 A durable, water resistant, computer-generated sample label is printed and affixed to each sample. Every sample container received from the client is uniquely identified on the label with the laboratory reference number and an alpha character (A, B, C) indicating the specific container. Sample preservation is verified and, if necessary, adjusted upon receipt or at the bench prior to analysis. For more information on sample preservation and storage, refer to the Sample Splitting, Preservation, Storage, and Disposal SOP (A06).

14.13.3 For microbiological samples, in addition to the Work Order Report and labels, the lab sheet may be printed from the LIMS.

15.0 IDENTIFICATION AND STORAGE OF SUBSAMPLES, EXTRACTS, AND DIGESTATES

15.1 Unique laboratory numbers generated by the LIMS identify all sample containers. When sub-samples, extracts and/or digestates are made, each additional container is uniquely identifiable. Sub-samples taken for preservation indicate the preservative added in addition to the SampleID number. Vials containing extracts for Organic determinations indicate the SampleID number, the Method Number and the extraction date. Digestate storage containers indicate the laboratory number and type of preparation – each preparation batch for the metal analyses on any one date is also color-coded. All sub-samples, extracts, and digestates are stored according to the applicable preservation or the test method requirements.

16.0 TRANSPORTATION OF SAMPLES

16.1 Once samples have been received, they do not leave the premises. Office employees personally place the samples in the refrigerator (temp 2-6 °C) in the proper holding section, in the proper area of the sample storage room, or in the proper analytical section of the lab. Storage of samples must follow preservation protocols. Any relevant instructions regarding storage accompanying the sample must be followed. Samples are stored away from standards, food, and other sources of potential contamination. Any pertinent information regarding the samples must be discussed with the Department Supervisor or Manager.

16.2 All analysts (names and dates) handling the sample are documented electronically in LIMS or on the paperwork associated with the sample and its analysis. Samples that have been completed are held in the storage area for at least one month – at which time they are disposed of in the proper manner. For more information concerning sample disposal refer to Pollution Prevention SOP S07. Occasionally, samples for litigation purposes might be held for a longer period of time at the request of the client or samples may be returned to the client. All doors in the laboratory are locked securely and the entry alarm is armed when no approved personnel are present.

17.0 EMPLOYEE ORIENTATION

17.1 All new employees receive orientation to the company and its mission during new hire training and orientation. Orientation includes familiarization with the E. S. Babcock & Sons, Inc. Employee Manual, the Quality Assurance Manual, the Ethics and Data Integrity Manual, and Laboratory Safety Training. Employees also receive training from the QA Department regarding QA procedures, NELAP standards, ISO 17025 Standards (when applicable), laboratory techniques, LIMS, and company information. See Appendix O for examples of training module outlines.

17.2 The Employee Manual discusses the standards of conduct, which are expected of all employees, including confidentiality of information. In detailing the contents of the Ethics and Data Integrity Manual, the employee also receives instruction regarding his/her ethical and legal responsibilities and the potential penalties for improper, unethical, or illegal actions. All employees are required to sign a statement acknowledging they have been provided with this information and that they have read and are familiar with the manuals. Statements are on file in the QA Files located in the QA office and also on the computer in the QA folder on the NAS server. As stated in the Ethics and Data Integrity Manual (Appendix F), an ESB Quality Control Follow-up Report may be used to document challenges presented to the Ethics and Data Integrity Program. However, if any possibility of serious potential unethical behavior has been raised, an official Ethics Investigation will be initiated and the committee will report its findings to the CEO.

18.0 STANDARD OPERATING PROCEDURES (SOPs)

18.1 ESB maintains Standard Operating Procedures (SOPs) that accurately reflect all phases of current laboratory activities such as assessing data integrity, corrective actions, handling customer complaints, and all test methods. Some features of the SOPs include:

18.1.1 These documents are internally written documents.

18.1.2 For analytical tests, copies of published methods are used initially until the internally written SOP has been developed. Any deviations from the test method are documented *in italics*.

18.1.3 Copies of all SOPs are accessible to all personnel. Personnel must read all SOPs that are applicable to their assigned tasks and sign a statement that they have done so.

18.1.4 SOPs are organized.

18.1.5 Each SOP clearly indicates the effective date of the document, the revision number and the signature(s) of the approving authority (the Quality Assurance Manager or her designee).

18.1.6 Analytical SOPs are reviewed and updated during routine method audits. Non-analytical SOPs are reviewed and, where necessary, revised to ensure continuing suitability and compliance with laboratory policies and quality control standards

19.0 THE LABORATORY METHOD MANUAL

19.1 The laboratory has and maintains in-house Methods Manuals consisting of individual SOPs for each accredited analyte or test method. For more information regarding SOPs, refer to the SOP Modification Policy SOP (Q23). These manuals consist of copies of published or referenced test methods or the laboratory SOP. Each SOP includes or references, where applicable:

19.1.1 Identification of the test method.

19.1.2 Applicable matrix or matrices.

19.1.3 Reporting and Detection limit.

19.1.4 Scope and application, including components to be analyzed.

19.1.5 Summary of the test method.

19.1.6 Definitions (see also the Definitions SOP Q15).

19.1.7 Interferences.

19.1.8 Safety (see also the Safety SOPs S01-S07).

19.1.9 Equipment and supplies (see also the Equipment Maintenance SOP Q21).

19.1.10 Reagents and standards (see also the Reagent Quality and Documentation SOP Q05 and the Standard Quality and Documentation SOP Q08).

19.1.11 Sample collection, preservation, shipment and storage (see also the Bottle Control SOP Q13, the Holding Times/Due Dates

SOP Q07, and the Sample Containers, Preservation Techniques, and Holding Times for Aqueous Matrices SOP Q14).

19.1.12 Quality control (see also the Quality Control Data SOP Q01).

19.1.13 Calibration and standardization.

19.1.14 Procedure (see also the General Laboratory Techniques SOP Q04 and the Good Automated Laboratory Practices SOP Q17).

19.1.15 Calculations.

19.1.16 Method performance.

19.1.17 Pollution prevention (see also Pollution Prevention SOP S07).

19.1.18 Data assessment and acceptance criteria for quality control measures (see also the Procedure for the Integration of Chromatographic Peaks SOP Q18).

19.1.19 Corrective actions for out-of-control data (see also the Corrective Action for Chemical Analyses SOP Q06).

19.1.20 Contingencies for handling out-of-control or unacceptable data.

19.1.21 Waste management (see also Pollution Prevention SOP S07).

19.1.22 References including instrument manual if applicable.

19.1.23 Any tables, diagrams, flowcharts and validation data.

19.2 It is the policy of Edward S. Babcock & Sons that the Quality Control protocols specified by the Laboratory Methods Manuals be followed.

20.0 DEMONSTRATION OF PROFICIENCY

20.1 In order to demonstrate the suitability of a test method for its intended purpose, Babcock Laboratories, Inc demonstrates and documents its ability to meet acceptance criteria either specified by the method, by the

Environmental Protection Agency (EPA), the State program requirements or other accrediting bodies such as A2LA. Acceptance criteria meet or exceed these requirements and demonstrate that the test method provides correct/expected results with respect to specified detection capabilities, selectivity, and reproducibility.

20.2 Microbiological Analyses

The Microbiology laboratory utilizes accepted (official) test methods or commercialized test kits for official test methods. Proficiency with the test method is demonstrated prior to first use. Microbiological test methods are validated in terms of specificity and reproducibility by the use of positive and negative controls covering all aspects of the test. The validation of microbiological test methods is performed under the same conditions as those for routine sample analysis. Individual microbiologist demonstration of capability is required prior to unsupervised sample analysis. For details, please see the Bacteriology General Procedures and Quality Control SOP (B01).

20.3 Chemical Analyses

20.3.1 Laboratory

When initiating a new analytical method, the laboratory performs a complete data package including SOP, calibration, MDL study, and an Initial Demonstration of Capability (IDOC) as required by the method and/or the certifying agency. A follow-up is performed on any analyte that fails the laboratory acceptance criteria and an additional IDOC is performed for that analyte.

20.3.2 Work Cells

Whenever there is a significant change in the method or instrument, where Work Cells are used, the group must perform an Initial Demonstration of Capability (IDOC) as a unit. When a new analyst is added to the cell, the analyst may work with an experienced analyst until the training period is completed and four Laboratory Control Samples

(LCS's) and Method Blank Samples (MB's) in four consecutive batches meet acceptance criteria. To demonstrate and document analyst proficiency, this data is recorded by the analyst using a Work Cell Change Form and submitted to the QA Department. If the new analyst cannot successfully complete the Work Cell Change, the cell must perform a new IDoC. In addition, if the entire Work Cell is changed/replaced, the Work Cell must perform an IDOC. (See instructions for IDOC in section 20.3.3.3 below).

20.3.3 Analyst Training Documentation

New employees or employees that are assigned new procedures undergo the following training:

20.3.3.1 The analyst reads the applicable SOP and is shown the procedure by the Supervisor or Manager or other designated trainer.

20.3.3.2 The analyst performs the procedure (or their part of the procedure when working with a Work Cell or Work Group) under direct supervision until the trainer is confident that the analyst can perform the procedure unsupervised.

20.3.3.3 The analyst performs an Initial Demonstration of Capability (IDOC). The IDOC is performed using either: 1) method specified procedure and criteria or, if the method does not specify 2) four aliquots of sample are analyzed at a concentration of 1-4 times the method or laboratory generated limit of quantitation. The aliquots may be either analyzed concurrently or over a period of several days (as long as they are consecutive for the analyst). The standards are from a source separate from the calibration. The average is calculated in the units used for reporting. The average and either the standard deviation or RSD are compared to method or, in the absence of method

requirements, in-house acceptance criteria for recovery and reproducibility. If standard is not available for spiking, four sample aliquots are analyzed at a readable concentration and compared to in-house acceptance criteria for reproducibility. After follow-up, test parameters that fail acceptance criteria are reanalyzed with additional aliquots until they meet the criteria. During this training period, the primary or secondary trainer will co-initial any analyses of client samples by the trainee. The completed IDOC certificate along with supporting raw data is kept in the QA files.

20.3.3.4 A training log is completed to document the training of the new analyst, including information such as the analyst name, trainer name, method, date SOP read, and date of IDOC or other demonstration.

20.3.3.5 The QA Department reviews proper documentation and calculations of the new analyst. The Demonstration of Capability Certificate Statement is approved by the Lab Director, and it is filed by the QA Department.

20.3.3.6 Annually, the analyst must perform a Demonstration of Continuing Proficiency (DOCP), as detailed in the Quality Control Data SOP (Q01). If the analyst has performed an IDOC during that calendar year, the IDOC will satisfy the requirement for that calendar year. If the analyst is part of a Work Cell that adds an employee with a Work Cell Change Form or has performed an IDOC those procedures will satisfy the requirement for that calendar year.

20.3.3.7 Demonstration of Capability Certification Statements -IDOC, DOCP, and Work Cell Change Form records are kept in the QA files.

Note: The training procedure is intended to ensure that personnel are adequately experienced in the duties they are expected to carry out and are receiving any needed training. The Laboratory Directors or Lab Manager certifies that personnel with appropriate education and/or technical background perform all tests for which the laboratory is accredited. Employees are chosen for specific tasks based on their abilities and experience. Refer to A12 Employee Training Procedure SOP for more information.

21.0 METHOD DETECTION LIMIT

21.1 The **method detection limit (MDL) or Limit of Detection (LOD)** is verified statistically for each analytical method and for aqueous and non-aqueous matrices, as applicable. A minimum of seven replicates of a spiked matrix are processed and analyzed at a concentration of 2.5-5 times the estimated method detection limit or per method specifications. The standard deviation is calculated. The statistical method detection limit is the standard deviation multiplied by the student's T factor for the number of replicates at a 99% confidence level and multiplied by any preparation or dilution factor (the student's T factor for seven replicates at a 99% confidence level is 3.14). The reporting limit (or limit of quantitation (LOQ)) must be equal to or above the calculated statistical MDL except for special organic analyses (see Q01 for reporting limit requirements). MDL studies for each analytical procedure are performed per method requirements or whenever major changes in the instrument or procedure occur.

21.2 On an annual basis the laboratory must confirm the validity of either the LOD (for results reported as J flag values) or the LOQ.

21.3 Confirmation of LOD

21.3.1 The validity of the LOD is confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix

containing the analyte at no more than 2-3X the LOD for the single analyte tests and 1-4X the LOD for multiple analyte tests. This verification is performed on every instrument that is to be used for analysis of samples and reporting of data.

21.3.2 An LOD study is not required for any component for which spiking solutions or quality control samples are not available, or when test results are not to be reported to the LOD. Where an LOD study is not performed, the laboratory may not report a value below the Limit of Quantitation.

21.4 Confirmation of LOQ

21.4.1 The validity of the LOQ is confirmed by successful analysis of a QC sample containing the analyte(s) of concern in each quality system matrix 1-2 times the claimed LOQ. A successful analysis is one where the recovery of each analyte is within the established test method acceptance criteria or client data quality objectives for accuracy.

21.4.2 The LOQ study is not required for any component or property for which spiking solutions or quality control samples are not commercially available or otherwise inappropriate (e.g., pH) or if the LOD has already been confirmed.

22.0 PROFICIENCY TESTING (PT) SAMPLES

22.1 Babcock Laboratories, Inc. participates in PT studies at least twice each year in each field of accreditation (per matrix-technology/method-analyte/analyte group) in order to maintain accreditation. Certified samples are purchased, where available, from a National Voluntary Laboratory Accreditation Program (NVLAP) approved vendor. PT samples for microbiology food and bottled beverage testing methods such as pathogens are obtained from AOAC International. AOAC's PT program provides PT samples at a rate of four times per year. AOAC PTs for food and bottled

beverage analyses are completed at a minimum of two activities per method/test type and/or technology per year. The lab's entire scope is covered over a four-year period at minimum.

22.2 For environmental PT samples, if the laboratory receives a "Not acceptable" result for a PT sample, a "Corrective Action: ESB PT Follow-up Form" is completed. The data is reviewed and the findings documented. These are reviewed by a QA Manager, signed by the Laboratory Director, and a copy is mailed to the accrediting authority/certifying body (for DMRQA studies, a copy is also sent to any affected DMRQA clients upon client request). If the laboratory receives a "Not acceptable" result for two out of three of the last PT samples, the laboratory will order supplemental PT samples from an approved vender (such as Environmental Resource Associates or Absolute Standards) at least 15 calendar days apart from the closing date of one study to the shipment date of another study for the same field of proficiency testing, until a history of passing two out of three PT samples is reestablished. Proficiency testing raw data and reports are retained in accordance with the laboratory records management policy. For more information regarding our PT program, please refer to the Proficiency Testing SOP (Q26).

22.3 For food testing and bottled beverage PT samples, if the laboratory receives an "Unsatisfactory" of "Failed" result for a PT sample, the Root Cause of the unsatisfactory result is promptly investigated. The investigation is complete once the problem has been rectified and the lab is able to achieve satisfactory performances for the test/method in question.

23.0 QUALITY CONTROL OF LABORATORY CONDITIONS

23.1 For details on laboratory technique, equipment, and instrumentation, see the Equipment Maintenance SOP (Q21) and the General Laboratory Technique SOP (Q04). The following is a general summary however, the current Q04 or Q21 SOP will supersede.

23.2 Equipment and Instrumentation

23.2.1 Examples of chemical instrumentation include Gas Chromatographs, Gas Chromatograph/Mass Spectrometers, Ion Chromatographs, Ion Chromatographs/ Mass Spectrometer/ Mass Spectrometers, High Performance Liquid Chromatograph, Inductively Coupled Plasma Emission Spectrophotometer, Inductively Coupled Plasma/Mass Spectrometer, Infra-red Spectrophotometer, UV-Visual Spectrophotometers, Total Organic Carbon Analyzer, Total Organic Halogen Analyzer, nephelometers, recorders, and integrators. Bacteriological equipment includes incubators, autoclaves, fecal water baths, agar water baths, dry ovens, microscopes and a mini-Vidas. A list of current equipment, manufacturer, model, serial numbers, date received, date placed in service, condition when received, and laboratory location is kept on file. See Appendix B for equipment list.

23.2.2 All instruments/equipment are calibrated and maintained in accordance with manufacturer's specifications, method requirements, and well-established quality assurance practices. (See Appendix J: Calibration and Quality Control Criteria Charts for method specific calibration information.) A copy of the manufacturer's instructions, when available, is kept with the instrument. Equipment is operated by authorized personnel only. The analyst using the instrument/equipment maintains the

instrument in clean and operating order. Problems are reported immediately so that they can be corrected. When an instrument is taken out of use due to a maintenance problem, a sign is placed on the instrument indicating the instrument is out of service. All major instruments are kept on maintenance contracts. Maintenance logs are kept for all major analytical equipment. All maintenance procedures routine and nonroutine are clearly documented in the log. When a new instrument is placed into service it is first calibrated and checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications. MDL and IDoC studies are performed, and a new instrument checklist must be completed and approved by QA prior to sample analysis. For more information regarding equipment, refer to the Equipment Maintenance SOP (Q21).

23.2.3 The temperatures of refrigerators, ovens, and incubators are monitored daily and recorded in a notebook along with the initials of the person performing the check. The temperatures of water baths are monitored daily (when in use). All thermometer calibrations are checked annually against an NIST certified thermometer at a level that is appropriate for its use. If a thermometer is broken, the calibration of the replacement is checked in such a way as to be NIST traceable before use. All calibration checks are recorded and any correction applied to the thermometer is recorded. A label indicating the calibration status is applied to each thermometer.

23.2.4 All glassware is rated as Class A. All glassware is cleaned to meet the sensitivity of the test method (e.g. acid rinsed for metal determination or solvent rinsed for organic determination). See

the appropriate analytical SOP for the glassware cleaning procedure required by that method.

23.2.5 Balances are calibrated and cleaned annually by an outside vendor. The sensitivity, reproducibility, and internal consistency are checked within the laboratory daily using certified weights. These weights are calibrated at least annually and the weight calibration certificates are in the QA files.

23.2.6 The pH meters are calibrated with each use using 7.0 and 10.0 buffers and verified by a 4.0 buffer.

23.2.7 The fume hood filter quality and velocities are monitored and recorded quarterly. Fume hoods are serviced annually.

23.3 Environmental Conditions

23.3.1 The laboratory ensures that the environmental conditions do not invalidate the results or adversely affect the required quality of any measurement. Measures have been implemented to isolate sensitive analyses and guard against cross contamination including restricting access to areas such as volatile analysis when solvent vapor contamination is a possibility. The laboratory adheres to specific environmental conditions specified in a test method or by regulation and where specified, documents compliance.

23.3.2 The laboratory monitors for contamination by processing a Method Blank with every analytical batch. In the event of contamination, environmental tests are stopped, and corrective action is taken. The client is notified if it is believed the contamination has affected the client's sample result.

23.3.3 The laboratory takes into account factors that contribute to the total uncertainty of measurement in developing environmental test methods and procedures, in the training and qualification of personnel, and in the selection and calibration of the equipment it uses.

23.3.4 See section 24.3.3.4 for details on uncertainty of measurement.

23.4 Reagents and Standards

23.4.1 Reagent water meets or exceeds ASTM Type II specifications. It is produced by a triple-stage commercial ion-exchange resin system. If higher quality water is desired, the water is then passed through a "Nanopure" system. All chemical reagents are ACS quality or better. Reagents are discarded and prepared fresh as required. The reagent name and date prepared shall serve as the unique identifier. If a second identical reagent is made on a given day, it will be designated with an additional letter so that the name and date remain unique. All standards are prepared from ACS reagents or purchased already standardized by a nationally known chemical manufacturer such as Baker, Eastman Kodak, B & J, Merk, Supelco, Mallinkrodt, Aldrich, Sigma, etc. The date received is recorded in the chemical inventory. The date opened is recorded on the bottle. New standard solutions are compared to a standard of a different manufacturer or lot number. If they fail to agree within method-acceptable criteria, then either the standard is re-made or both standards are compared to another standard from a third source.

23.4.2 A standard log is maintained either in the logbook or LIMS and a reagent logbook is maintained to document the traceability of standards and reagents and record the manufacturer, lot number, concentration, preparer, and date of preparation. Whenever a

new product is ordered, it is checked to verify that it meets specific method requirements.

23.4.3 For further details on the handling and use of reagents and standards, refer to the Reagent Quality and Documentation SOP and the Standard Quality and Documentation SOP (Q05 and Q08, respectively).

24.0 QUALITY CONTROL OF ANALYTICAL PROCEDURES

24.1 See the Quality Control Data SOP (Q01) and Bacteriology General Procedures and Quality Control (B01) for details and Appendix G for QA References.

24.2 Chemical Determinations:

24.2.1 Method QC
Calibration curves and linearity checks are run as prescribed in the applicable method for each procedure and for all parameters. All quality control requirements of each method must be met.

24.2.2 Batch QC

24.2.2.1 A batch is a set of 20 or fewer samples of a similar matrix that are processed together with the same method and personnel, using the same lots of reagents.

24.2.2.2 A Laboratory Control Sample (LCS), a Method Blank (MB), a Matrix Spike (MS) and Matrix Spike Duplicate (MSD), sample Duplicate (Dup), or Laboratory Control Sample Duplicate (LCSD) may be analyzed for each batch per method requirements. A Dup is analyzed in place of the MS and MSD for gravimetric or titrimetric analyses. Where the method does not require MS/MSD or Dup, an LCS duplicate (LCSD) may be used to gather precision data

instead. Note: Other documents may refer to these QC samples in different ways. For example, EPA 500 series methods refer to an LCS as a Laboratory Fortified Blank (LFB) and an MS as a Laboratory Fortified Matrix (LFM). Element refers to an LCS as a Blank Spike (BS).

24.2.2.3 Batch Controls:

24.2.2.3.1 The MB is used to assess the preparation batch for possible contamination during the preparation and processing steps. The MB shall be processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure. The MB documents the purity of any reagents or waters used. Under NELAC rules, a MB shall consist of a matrix that is similar to the associated samples and is known to be free of the analyte of interest.

24.2.2.3.2 The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. The LCS is analyzed at a minimum of 1 per preparation batch. Exceptions would be for those analytes for which no spiking solutions are available. The LCS is a controlled matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes.

24.2.2.4 Sample Specific Controls

24.2.2.4.1 Sample specific controls determine the effect of the sample matrix on method performance. They are designed as data quality indicators for

a specific sample using the designated test method. These controls do not evaluate laboratory performance of an entire batch. Examples include: MS, MSD, Dup and surrogate spikes (Surr).

24.2.2.4.2 MS/MSD indicates the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information is sample/matrix specific and would not normally be used to determine the validity of the entire batch.

24.2.2.4.3 Duplicates are replicate aliquots of the same actual sample taken through the entire analytical procedure to indicate the precision of the results for the specific sample using the selected method. They provide a usable measure of precision only when the target analytes are found in sufficient quantity in the sample chosen for duplication.

24.2.2.4.4 The evaluated MS recoveries (or duplicate data in the absence of MS data) are in our estimation a valid approximation of method uncertainty for that matrix. MS data is an indication of correctness and reliability of the environmental tests including contributions from: human factors, accommodation and environmental conditions, environmental test methods and method validation, equipment, measurement

traceability, sampling, and the handling of samples. MS and duplicate recoveries are presented to the user in a standard report. See SOP Q03 section 5.0 for more information.

24.2.2.4.5 Surrogate compounds represent the various chemistries of the target analytes in the method. They are deliberately chosen because they are unlikely to occur as an environmental contaminant.

24.2.2.5 Other QC

24.2.2.5.1 External QC reference samples are obtained from an outside source for inclusion in our procedures for method verification. External QC reference samples from an appropriate source, such as Environmental Resource Associates or Absolute Standards, are analyzed semi-annually.

24.2.2.5.2 Internal standards are routinely included with determinations of metals and organics; also methods of addition may be incorporated. An internal standard (IS) is a pure compound that is not a contaminant in the sample and is added to a sample or sample extract in a known amount. The IS is used to measure the relative responses of target analytes and surrogates that are in the same sample. When an IS is used, it is added to the samples and QC samples or their extracts.

24.2.2.5.3 Non-routine samples with complex or unfamiliar matrices might need special QC, such as additional procedural spikes or two or more

dissimilar methods of analysis. All batch QC is reviewed daily.

24.3 Bacteriological Determinations:

There are general procedures and quality control (QC) requirements that are unique to Bacteriological Determinations. These include sample container sterility checks, glassware cleaning procedures, housekeeping requirements, media maintenance/preparation/QC, dilution water requirements, instrument calibration, monitoring of incubators/water bath/dry oven, autoclave use and QC documentation (including the use of biological indicators of sterilization efficiency), reference culture requirements, and quality control analyses. For details, please refer to the Bacteriology General Procedures and Quality Control SOP (B01).

25.0 STATISTICAL EVALUATION OF DATA FROM CHEMICAL ANALYSES

25.1 The laboratory has quality control procedures for monitoring the validity of analytical tests undertaken. The resulting data is recorded in such a way that trends are detectable (refer to the Statistical Evaluation of Data SOP (Q03)), and when practical, statistical techniques are applied to the reviewing of the results (please refer to section 26).

25.2 All samples are analyzed within analytical batches. An analytical batch includes the QC samples discussed in Section 24 and any calibration and instrument checks required by the method.

25.3 Calibration curves for most analyses are a minimum of three points. Some methods require additional points in the calibration curve. Calibration requirements that are specified in the applicable test method must be met. See Appendix J for Calibration and Quality Control Criteria Charts.

25.4 The data from LCS's, MS's, MSD's, Duplicates, and Surrogates are used for statistical evaluation. This is based on the following examinations:

25.4.1 From duplicates, both of spikes and samples, precision data is calculated and the **Relative Percent Difference (RPD)** is determined. The equation is:

$$\text{Relative Percent Difference} = \frac{|A - B|}{\left(\frac{A + B}{2}\right)} \times 100$$

Where *A* is the analytical result for the matrix spike (or sample) and *B* is the analytical result for the matrix spike duplicate (or sample duplicate).

25.4.2 From results of the **MS/MSD** (S) accuracy data is calculated and the **percent recovery (%Rec)** is determined. The equation is:

$$\text{Percent Recovery} = \frac{|\text{M - A}|}{\text{Q}} \times 100$$

Where M is the matrix spike analytical result, A is the analytical result of the (unspiked) sample, and Q is the amount of spike added.

25.4.3 An **LCS percent recovery (%Rec)** is calculated by comparing the LCS analytical result (A) to the "True" value, which is the expected value of the spike (Q) (or the historical average of the control).

$$\text{Percent recovery} = \frac{\text{A}}{\text{Q}} \times 100$$

If the percent recovery is not within the laboratory acceptance criteria, the analysis is considered to be "out of control" and will not continue until the cause is found and corrective measures are taken. Any affected samples associated with the out-of-control LCS are reprocessed for re-analysis or the results are reported with appropriate data qualifying codes.

25.4.4 The **relative standard deviation (RSD)** may be determined from the QC data using the following equation:

$$\text{Relative Standard Deviation} = \frac{S}{\overline{X}} \times 100$$

Where:

$$S = \sqrt{\frac{\sum(X - \overline{X})^2}{N-1}}$$

Where S is the standard deviation, $\overline{X}$ is the mean of the observed value, X is the observed value, and *N* is the number of observations.

25.5 Control charts are generated in the LIMS. For details, please refer to the Statistical Evaluation of Data SOP (Q03).

26.0 DATA REDUCTION AND VALIDATION

26.1 To ensure the quality of the data, several review steps are incorporated into the data review process. For details refer to the Data Review and Validation SOP (Q10). In summary, the first level of review is the analyst who preliminarily assesses whether the batch QC acceptance criteria are met, adds qualifiers as appropriate and checks calculations, units, significant figures and dilution or concentration factors. The Peer Reviewers performs the second level of review. The Department Supervisor or Manager review follows, including a check to determine if proper relationships exist among the parameters in the sample. The Standard Methods SM 1030 F procedure may be also used along with the following:

26.2 Mineral Balances

Equation (1) for Total Cations (me/L)

Ca + Mg + Na + K + NH_3-N = total cations

Equation (2) for Total Anions (me/L)

$CO_3 + HCO_3 + OH + SO_4 + Cl + NO_3 + F$ = total anions

Equation (3) for Calculated TDS (mg/L)

Calculated TDS = Ca + Mg + Na + K + Cl + SO_4 + NO_3 + F + SiO_2
+ (0.6 × Total Alkalinity as $CaCO_3$)

The measured TDS may be higher than the calculated TDS because a significant contributor may not be in the calculation.

Equation (4) for Cation/Anion Balance

$$\text{Balance Acceptance Criteria} = 100 \times \frac{(\text{total cations} - \text{total anions})}{(\text{total cations} + \text{total anions})}$$

The result should be 100 ± 5%.

Equation (5) for Calculated Specific Conductance

EC (Calc) = (total cations + total anions) × 50

(Both the total anion and total cations should be 1/100 of the measured EC value.) The calculated EC is expected to be within 10% of the measured EC. Thus:

Equation (6)

$$0.9 \leq \frac{EC_{calculated}}{EC_{measured}} \leq 1.1$$

If the ratio of TDS to conductivity falls below 0.55, the lower ion sum is suspect and reanalyzed. If the ratio is above 0.7, the higher ion sum is suspect and reanalyzed. If reanalysis causes no change in the lower ion sums, an unmeasured constituent, such as nitrite or organic acids may be present at significant levels. If poorly disassociated calcium and sulfate ions are present, the TDS may be higher than the EC. The acceptance criterion is as follows:

Equation (7)

$$\frac{TDS_{measured}}{EC_{measured}} = 0.55 - 0.70$$

and/or

Reference: Standard Methods for the Examination of Water and Wastewater, APHA,

$$\frac{TDS_{calculated}}{EC_{calculated}} = 0.55 - 0.70$$

AWWA, WEF, 18th edition

26.3 Demand Ratios

A general rule of thumb is:

BOD = 0.40-0.60 of COD

TOC = 0.40 of COD (approximately)

TOC = 0.60 of BOD (approximately)

26.4 Nutrient Relationships

Total Nitrogen = Organic Nitrogen + Inorganic Nitrogen

Inorganic Nitrogen = NO_3-N + NO_2-N + NH_3-N

Kjeldahl Nitrogen = Organic Nitrogen + NH_3-N

Organic Nitrogen = Kjeldahl Nitrogen - NH_3-N

The above nitrogen relationships are checked to ensure proper calculations have been performed.

26.5 Trace Organic Contaminants:

TOX = Volatile Organic Halogens + Non-volatile Organic Halogens

Volatile Organic Halogens = Polar + Non-polar Volatile Organic Halogens

Non-volatile Organic Halogens = Polar + Non-polar Non-volatile Organic Halogens

Non-polar Volatile Organic Halogens are measured from EPA Methods 524, 624, or 8260.

Non-polar Non-volatile Organic Halogens are measured from EPA Method 525, 625, or 8270 analysis.

From the above relationships, the following is performed:

TOX $\geq$ Non-polar (Volatile + Non-volatile) Organic Halides

26.6 The Inorganic Department Manager, Supervisor, or Lab Director approves the results in the computer when all analyses requested on the sample are completed.

27.0 FINAL REPORT REVIEW

27.1 For some reports the QA Manager or a Project Manager (or other authorized person) will also review the data just prior to generating the final report. These reports are generally given an extra review due to project-specific requirements such as an analyte list or reporting limit that is not typical, such as a request to report of J-flag values, or a request for a higher level QC (see Section 29 for further details on reporting of results). The initials and date of review are recorded on the Work Order report or recorded in LIMS as part of the data audit trail.

27.2 After the final report is generated, the Project Managers (or other authorized signatory) will be responsible for final review and signing of the report. Electronic Signatures are utilized for reports that are delivered electronically to clients.

27.3 Each reviewer (Analyst, Peer Reviewer, Supervisor or Manager, QA Manager/Project Manager, and Laboratory Director) verifies that the data have been reported accurately, clearly, unambiguously, and objectively.

28.0 CORRECTIVE ACTION FOR OUT-OF-CONTROL QC

28.1 For details on corrective action, see the Corrective Action SOP (Q06) and the SOP for the method. The following is a general summary however, the current Q06 or method SOP will supersede.

28.2 For Chemical Determinations

28.2.1 Corrective action is necessary when the upper or lower control limits for the test parameters have been exceeded for laboratory control samples or when processed blanks show an unacceptable level of contamination.

28.2.2 The first step taken when QC results are "out of control" is to recheck all mathematical calculations including such items as concentration and/or dilution factors and calibration curve readings.

28.2.3 If the first step fails to solve the problem then the reagents are checked for proper chemical reaction, for example, the esterification potency for EPA Method 8151.

28.2.4 Reagents and glassware are checked for contamination. Reagent blanks are checked containing the acids used in metal digestion or the solvents used in organic analysis.

28.2.5 Standards are checked for proper concentration. New standards from a different supplier/lot number are prepared to check against the standards used during the analysis in question.

28.2.6 When a batch of data is transferred or manually entered into the laboratory database and later found to be in error OR to need re-running for verification a follow-up is initiated by the analyst, with

corroboration from the Peer Reviewer, Supervisor or Manager. The answers in the database are flagged as suspect until the problem can be resolved and the status remains at pending. Samples affected are either reanalyzed or verified. If the problem is not corrected, or the holding time has been exceeded or there is insufficient sample for a follow-up—the client is notified so that it can be determined if the site should be resampled. If suspect results are reported, the report is flagged with a note indicating the problem.

28.3 For Bacteriological Determinations

28.3.1 Corrective action is necessary when QC cultures show atypical response or when check sample results exceed the given acceptance criteria. The associated samples and quality control data are reviewed to verify sterility and findings are documented on the associated lab sheet(s), in LIMS or a follow-up form.

28.4 For All Analyses

28.4.1 Quality Control Follow-Up Forms are generated when QC problems cannot be corrected during the run and documented in the analytical data itself. Quality Control Follow-Up Forms are available to document the situation and resolution, refer to the Quality Control Follow-Up Forms SOP (Q24) for further details. As appropriate for the test method in question, further corrective actions, such as troubleshooting instrumentation and re-calibration may be performed.

28.4.2 Quality control data is analyzed for all analyses. When this quality control data is found to be outside pre-defined criteria, planned action is taken to correct the problem and to prevent the reporting of incorrect results.

29.0 REPORTING OF RESULTS

29.1 Analytical Chemistry Reporting Procedure

The final copy of the report contains all information necessary for the interpretation of the test results and all information required by the method user presented in a simplified and straight forward manner– including the following information:

29.1.1 A report title.

29.1.2 The name of the laboratory.

29.1.3 The address of the laboratory.

29.1.4 The phone number of the laboratory.

29.1.5 Laboratory identification number.

29.1.6 Unique page identification.

29.1.7 Name and address of client and project name, if applicable.

29.1.8 Description and unambiguous identification of test sample—including the client identification code.

29.1.9 Analytical results including units and reporting limit (RDL).

29.1.10 Identification of any quality control failure within the batch that might affect the validity of the result by use of appropriate data qualifiers.

29.1.11 The reported units for samples are as received, unless identified as "dry" (corrected for dry weight).

29.1.12 Qualification of results derived from samples that did not meet acceptance requirements – such as improper container, holding time or preservative.

29.1.13 Date of receipt of sample, name of the submitter, date and time of sample collection, name of the sampler (if known), date(s) and time(s) of analytical test(s), and analyst(s) initials.

29.1.14 Identification of the test method used or a description of any non-standard test used.

29.1.15 Any other information relevant to the specific test.

29.1.16 Definition of data qualifiers.

29.1.17 The approval signature and title of the signatory (or electronic equivalent).

29.1.18 A statement attesting to the quality standards that are applied to the generation of analytical results or where applicable, reasons that the analysis did not conform to NELAP specifications.

29.1.19 Where applicable, clear indication of numerical results with values outside of quantitation limits.

29.1.20 Where applicable, a statement to the effect that the results relate only to the items tested or to the sample as received by the laboratory.

29.1.21 Where relevant, a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory.

29.1.22 Where applicable, clear identification of all data provided by outside sources, such as subcontracted laboratories, clients, etc.

29.1.23 Where applicable, amended reports include a case narrative or cover letter indicating that they are amended, the reason for amendment, and the date of the previous report that they supersede.

29.1.24 Where applicable, Non-NELAP accredited work is clearly identified by including a note in the analyte name, or by a "*" in the units of the affected analyte, along with a definition footer in the report.

29.1.25 Where applicable, the laboratory provides all the required information to their client for use in preparing monthly regulatory reports.

Note: A summary report is available upon request. If some of the above information is not presented in this report format it is readily available from the laboratory.

29.2 Reporting Records

All paperwork that is submitted by the client and the original Chain of Custody forms are attached to the work order. This is stored in the client files. Whenever format allows, electronic copies of amended reports are traceable internally by a date and time stamp.

29.3 Subcontracted Analyses

29.3.1 The laboratory clearly indicates to the client its intention to subcontract laboratory work in its contract bids and bid quotes.

29.3.2 When a subcontract lab is utilized, clients are sent the original reports from the subcontract lab. Babcock Laboratories, Inc. does not report subcontracted results on company letterhead (with the exception of transcribed results onto state forms for reporting to the state Office of Drinking Water. This is clearly noted on the report.)

29.3.3 All subcontracted analyses are to be performed by a NELAP accredited laboratory or by a laboratory that meets applicable statutory and regulatory requirements for performing the tests (i.e. a CA ELAP certified laboratory). Subcontract laboratories' current certifications are kept on file in the office of the Vice President of Sales and Marketing.

29.3.4 Subcontract laboratories are audited periodically. Audits consist of a two to three person panel over a 4 hour time period, reviewing laboratory documents, touring the facility, and questioning staff to determine if NELAP and ESB quality standards are being upheld.

29.3.5 Subcontract results are reviewed prior to sending to the client. Verification of analysis reporting levels in the form of a calibration standard at the RL is kept on file.

29.3.6 For more information refer to the Review of Contracts and Tenders SOP (A13).

29.4 Mandated Verbal Notification to Water Systems

29.4.1 The laboratory notifies the water system personnel immediately if Coliform is found in the presence/absence Coliform test, there are any Coliform positive tubes, or the sample is declared invalid due to a turbid culture with the absence of gas production using either the multiple tube fermentation technique or the presence/absence Coliform test. Following the Total Coliform Rule, follow-up samples are taken until the samples are negative for Coliform (see the Microbiology Notification and Reporting Procedures SOP BO8, for further details).

29.4.2 The laboratory notifies the water system personnel if a final drinking water nitrate result exceeds the MCL of 45 mg/L (as NO_3, or 10 mg/L as N). Notification is performed within 24 hours of obtaining a verified result. Once notified, the client must resample and the laboratory must reanalyze within a 24 hour period. Refer to Inorganic Ions by Ion Chromatography SOP I19 for further details.

29.4.3 The laboratory notifies the water system personnel if a final drinking water perchlorate result exceeds the MCL of 6.4ug/L. Notification is performed within 48 hours of obtaining a verified result. Once notified, the client must resample and the laboratory

must reanalyze within a 48 hour period. Refer to Perchlorate by Ion Chromatography SOP I19B for further details.

29.5 Quality Control Reports:

29.5.1 QC data are available for all chemical batches and are reported to the client upon request. Each project will be assigned a type of data package (or QC Level) based on the objectives of their project and this will determine the amount of QC data included in the final report.

29.5.2 The **Level I or "short report"** data packages are created from data in the Laboratory Information Management System (LIMS, Element). Level I data packages receive our general data review procedure and include Client Information, Work Order, Sample Information, Analyte(s), Result, Reportable Detection Limit (RDL), Units, Method, Analysis Date, and Analyst information. Data qualifier flags will only appear as needed.

29.5.3 The **Level II or "standard report"** data packages are created from data in the LIMS. Level II data packages receive our general data review procedures and review by a Project Manager or QA Manager (the Work Order Report will indicate that the report "Needs QC"). Standard reports include all elements of the short report. In addition, the Batch Quality Control data for the QC samples are provided. The Batch ID and Method appear as the heading above each set of Batch QC. Each QC sample will have information on the Date Prepared, Date Analyzed, Analyte(s), Result, Reportable Detection Limit (RDL), and Units. As discussed in Section 24, the QC samples will vary by method but LIMS reports may include data on the Blanks, Laboratory Control Samples/Spikes, Laboratory Control Samples/Spikes Duplicates,

Matrix Spikes, Matrix Spike Duplicates, and Sample Duplicates. Where applicable, the following data are included with each type of QC sample:

29.5.3.1 Laboratory Control Samples/Spikes:

29.5.3.1.1 Spike Level and

29.5.3.1.2 Accuracy (Percent Recovery [%Rec] and %Rec Limits)

29.5.3.2 Laboratory Control Samples/Spikes Duplicates:

29.5.3.2.1 Spike Level

29.5.3.2.2 Accuracy (%Rec and %Rec Limits), and

29.5.3.2.3 Precision (Relative Percent Difference [RPD] and RPD Limit)

29.5.3.3 Matrix Spikes:

29.5.3.3.1 Source Result,

29.5.3.3.2 Spike Level, and

29.5.3.3.3 Accuracy (%Rec and %Rec Limits)

29.5.3.4 Matrix Spike Duplicates:

29.5.3.4.1 Source Result,

29.5.3.4.2 Spike Level,

29.5.3.4.3 Accuracy (%Rec and %Rec Limits), and

29.5.3.4.4 Precision (RPD and RPD Limit)

29.5.3.5 Sample Duplicates:

29.5.3.5.1 Source Result and

29.5.3.5.2 Precision (RPD and RPD Limit)

29.6 Higher level data packages are created from data in the LIMS and also include special data packages created by a Project Manager. Higher level data packages receive our general data review procedures and review by a Project Manager. **Level III** data packages include all elements of the standard report with the addition of run logs/bench sheets and calibration curves. **Level III+** data packages include all elements of the standard report

with the addition of run logs/bench sheets, calibration curves, and raw data (chromatograms etc.). **Level IV** data packages include all elements of the standard report with the addition of run log/bench sheet, calibration curves, raw data (chromatograms etc.), and standard logs. **Custom** QC packages, electronic versions of the data, and other variations are also available to meet the specific needs of each project and will be established on client/project basis.

29.7 In addition, reports are available with **J-flag** data. J-flag reports include estimated values for results that fall between the Method Detection Limit (MDL) and Reportable Detection Limit (RDL). The MDL is listed for each analyte. A J-flag report receives our general data review procedures and a review by a Project Manager or QA Manager (the Work Order Report will indicate that the report needs "J-flag").

30.0 AUDITS

30.1 Method Audits

Audits of all analytical methods are performed periodically and in accordance with a predetermined schedule, conducted by the Quality Assurance Department to ensure that its operations continue to comply with quality assurance policies, the requirements of the management system, method and NELAP or ISO 17025 requirements. QA Department personnel are independent of the activities being audited (See Appendix M for example Audit Forms).

30.2 Internal Quality System Audits

The QA Manager and/or other trained and qualified personnel conduct an annual audit of the laboratory with relation to both the NELAC Chapter 5 and ISO 17025:2005 requirements to determine that the laboratory operation continues to comply with the laboratory's quality and management systems. The current NELAP Quality System Checklist as well as the A2LA "C101"

General Checklist: ISO/IEC 17025 Laboratory Accreditation Program are used together to conduct this audit. Laboratory documentation used to satisfy these requirements are referenced on the checklists. Results of these audits are reported to management for review. If results cast doubt on the correctness or validity of the laboratories calibrations or test results, the laboratory shall take immediate corrective action and shall immediately notify, in writing, any client whose samples were involved. For more information regarding these audits, please refer to the Audit Standard Operating Procedure (Q16).

30.3 Managerial Audits

The QA Manager conducts a review, annually, of its quality and management system and its testing and calibration activities. The purpose of this annual review is to ensure the quality and management's systems continuing suitability and effectiveness and to introduce any necessary changes or continuous improvements in the effectiveness of the quality system, management system and laboratory operations. The review addresses the suitability of policies and procedures, reports from managerial and supervisory personnel, the outcome of recent internal audits, assessments by external bodies, the results of interlaboratory comparisons or proficiency tests, any changes in the volume and type of work undertaken, feedback and complaints from clients, corrective and preventive actions, outcome of Root Cause Analysis investigations including recommendations for continuous improvement and other relevant factors such as Quality Control activities, resources, and staff training. The laboratory has a procedure for review by management and maintains records of review findings and actions. For more information regarding these audits, please refer to the Audit Standard Operating Procedure (Q16).

30.4 Audit Reviews

All audit and review findings and any corrective actions that arise from them are documented. The laboratory management ensures that these actions are discharged within the agreed time frame.

31.0 Quality Assurance Manual – Updates and Reviews:

31.1 This QA Manual is designed to be compliant with NELAC requirements (see NELAC Quality System Information Section 5.4.2.3 in Appendix I for list of requirements) and ISO 17025 requirements. The contents of this manual are reviewed annually (at a minimum) by the QA Manager and the Laboratory Directors for compliance to applicable regulations – ensuring that it reflects existing practices within the laboratory.

31.2 The QA Manual clearly indicates the revision month and the effective date. The effective date indicates that at midnight at the start of the effective date the new manual goes into effect.

31.3 All signatory personnel within the laboratory document their approval by signing of each new version of this document prior to its release.

31.4 The QA Manager maintains an archive of previous versions of this document.

31.5 All employees read the effective revision of the QA Manual and are familiar with its contents. Each employee signs a statement that he/she has read the QA Manual and declares his/her intention of complying with the requirements contained within Babcock Laboratories, Inc QA Manual.

32.0 APPENDICES

A. Copies of Certifications

B. Equipment List & Facility Maps

C. Organizational Chart

D. Resumes of Key Personnel

E. Job Descriptions of Key Personnel

F. Ethics and Data Integrity Manual

G. References for QA Procedures

H. References for Sampling Procedures

I. NELAC Quality System Information - excerpts from Chapter 5 & ISO 17025 Information-excerpts from standard

J. Calibration and Quality Control Criteria Charts

K. Sample Forms: Chain of Custody and Sample Receipt

L. Sample Preservation and Holding Times

M. Documentation Audit Forms

N. Sample Transportation for Third Party Couriers (SOP F14)

O. Training Module Outlines

Appendix A Copies of Certifications

NELAP - RECOGNIZED

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM BRANCH

CERTIFICATE OF NELAP ACCREDITATION

Is hereby granted to

Edward S. Babcock & Sons, Inc.

6100 & 6110 Quail Valley Court

Riverside, CA 92507

Scope of the Certificate is limited to the
"NELAP Fields of Accreditation"
which accompany this Certificate.

Continued accredited status depends on successful
ongoing participation in the program.

This Certificate is granted in accordance with provisions of
Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **02101CA**

Expiration Date: **1/31/2012**

Effective Date: **2/1/2011**

Richmond, California
subject to forfeiture or revocation

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

State of California—Health and Human Services Agency
California Department of Public Health

MARK B HORTON, MD, MSPH
Director

ARNOLD SCHWARZENEGGER
Governor

December 24, 2010

LAWRENCE CHRYSTAL
EDWARD S. BABCOCK & SONS, INC.
PO BOX 432
RIVERSIDE, CA 92502-0432

Dear LAWRENCE CHRYSTAL: Certificate No. 02101CA

This is to advise you that the laboratory named above has been accredited under National Environmental Laboratory Accreditation Program (NELAP) as an environmental testing laboratory pursuant to the provisions of the Health and Safety Code (HSC), Division 101, Part 1, Chapter 4, Section 100825, et seq.

The Fields of Accreditation for which this laboratory has been accredited are enclosed. Accreditation shall remain in effect until **January 31, 2012** unless revoked by ELAP or withdrawn at your written request. To maintain accreditation, the laboratory shall comply with the National Environmental Laboratory Accreditation Conference (NELAC) Standards and all associated California Environmental Laboratory Accreditation Program Branch (ELAP) regulations and statutes.

The application for renewal of this certificate must be received before the expiration date of this certificate to remain in force according to the HSC 100845(a).

Please note that your laboratory is required to notify California ELAP of any major changes in key accreditation criteria within 30 calendar days of the change. This written notification includes, but is not limited to, changes in ownership, location, key personnel, and major instrumentation (HSC 100845(b) and (d), and NELAC Standard Section 4.3.2). The certificate must be returned to California ELAP upon loss of accredited status.

Your continued cooperation with the above requirements is essential for maintaining the high quality of the data produced by environmental laboratories accredited by the State of California.

If you have any questions, please contact Rosalinda Lomboy at (213) 580-5731.

Sincerely,

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

Enclosure

CALIFORNIA DEPARTMENT OF PUBLIC HEALTH

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM - NELAP RECOGNIZED

NELAP Fields of Accreditation

EDWARD S. BABCOCK & SONS, INC.
6100 & 6110 QUAIL VALLEY COURT
RIVERSIDE, CA 92507
Phone: (951) 653-3351

Certificate No.: 02101CA
Renew Date: 1/31/2012

101 - Microbiology of Drinking Water			
101.010	001	SM9215B	Heterotrophic Bacteria
101.020	001	SM9221A,B	Total Coliform
101.021	001	SM9221E (MTF/EC)	Fecal Coliform
101.022	001	CFR 141.21(f)(6)(i) (MTF/EC+MUG)	E. coli
101.050	001	SM9222A,B,C	Total Coliform
101.051	001	SM9221E (MF/EC)	Fecal Coliform
101.052	001	CFR 141.21(f)(6)(i) (MF/EC+MUG)	E. coli
101.060	002	SM9223	Total Coliform
101.060	003	SM9223	E. coli
101.070	002	Colisure	Total Coliform
101.070	003	Colisure	E. coli
101.120	001	SM9221A,B,C	Total Coliform (Enumeration)
101.130	001	SM9221E (MTF/EC)	Fecal Coliform (Enumeration)
101.140	001	SM9222A,B,C	Total Coliform (Enumeration)
101.160	001	SM9223	Total Coliform (Enumeration)
101.200	001	SM9223B	E. coli (Enumeration)
101.210	001	SM9221B.1/SM9221F	E. coli (Enumeration)
102 - Inorganic Chemistry of Drinking Water			
102.022	001	SM2130B	Turbidity
102.030	003	EPA 300.0	Chloride
102.030	006	EPA 300.0	Nitrate
102.030	010	EPA 300.0	Sulfate
102.040	001	EPA 300.1	Bromide
102.040	002	EPA 300.1	Chlorite
102.040	003	EPA 300.1	Chlorate
102.040	004	EPA 300.1	Bromate
102.045	001	EPA 314.0	Perchlorate
102.048	001	EPA 332.0	Perchlorate
102.100	001	SM2320B	Alkalinity
102.110	001	SM2330B	Corrosivity (Langlier Index)
102.120	001	SM2340B	Hardness
102.130	001	SM2510B	Conductivity
102.140	001	SM2540C	Total Dissolved Solids

As of 12/24/2010, this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

102.163	001	SM4500-Cl G	Chlorine, Free and Total
102.180	001	SM4500-ClO2 D	Chlorine Dioxide
102.190	001	SM4500-CN E	Cyanide, Total
102.192	001	SM4500-CN G	Cyanide, amenable
102.200	001	SM4500-F C	Fluoride
102.210	001	SM4500-H+ B	pH
102.220	001	SM4500-NO2 B	Nitrite
102.240	001	SM4500-P E	Phosphate, Ortho
102.260	001	SM5310B	Total Organic Carbon
102.261	001	SM5310B	DOC
102.261	002	SM5310B	TOC/DOC
102.270	001	SM5540C	Surfactants
102.280	001	SM5910B	UV254
102.510	006	SM3120B	Hardness (calc.)
102.520	001	EPA 200.7	Calcium
102.520	002	EPA 200.7	Magnesium
102.520	003	EPA 200.7	Potassium
102.520	004	EPA 200.7	Silica
102.520	005	EPA 200.7	Sodium
102.520	006	EPA 200.7	Hardness (calc.)

103 - Toxic Chemical Elements of Drinking Water

103.030	001	SM3112B	Mercury
103.130	001	EPA 200.7	Aluminum
103.130	003	EPA 200.7	Barium
103.130	004	EPA 200.7	Beryllium
103.130	005	EPA 200.7	Cadmium
103.130	007	EPA 200.7	Chromium
103.130	008	EPA 200.7	Copper
103.130	009	EPA 200.7	Iron
103.130	011	EPA 200.7	Manganese
103.130	012	EPA 200.7	Nickel
103.130	015	EPA 200.7	Silver
103.130	017	EPA 200.7	Zinc
103.140	001	EPA 200.8	Aluminum
103.140	002	EPA 200.8	Antimony
103.140	003	EPA 200.8	Arsenic
103.140	004	EPA 200.8	Barium
103.140	005	EPA 200.8	Beryllium
103.140	006	EPA 200.8	Cadmium
103.140	007	EPA 200.8	Chromium
103.140	008	EPA 200.8	Copper

103.140	009	EPA 200.8	Lead
103.140	010	EPA 200.8	Manganese
103.140	011	EPA 200.8	Mercury
103.140	012	EPA 200.8	Nickel
103.140	013	EPA 200.8	Selenium
103.140	014	EPA 200.8	Silver
103.140	015	EPA 200.8	Thallium
103.140	016	EPA 200.8	Zinc

104 - Volatile Organic Chemistry of Drinking Water

104.030	004	EPA 504.1	EDB and DBCP
104.040	000	EPA 524.2	Volatile Organic Compounds
104.045	005	EPA 524.2	Trihalomethanes
104.050	011	EPA 524.2	Oxygenates

105 - Semi-volatile Organic Chemistry of Drinking Water

105.040	000	EPA 508	Chlorinated Pesticides
105.040	016	EPA 508	PCBs as Aroclors (screen)
105.082	009	EPA 515.3	Chlorinated Acids
105.090	029	EPA 525.2	Polynuclear Aromatic Hydrocarbons
105.090	030	EPA 525.2	Adipates
105.090	031	EPA 525.2	Phthalates
105.090	032	EPA 525.2	Other Extractables
105.090	034	EPA 525.2	Pesticides
105.140	001	EPA 548.1	Endothall
105.190	009	SM6251B	Haloacetic Acids

106 - Radiochemistry of Drinking Water

106.092	001	EPA 200.8	Uranium

107 - Microbiology of Wastewater

107.010	001	SM9215B	Heterotrophic Bacteria
107.020	001	SM9221B	Total Coliform
107.030	001	SM9221B	Total Coliform with Chlorine Present
107.040	001	SM9221C,E (MTF/EC)	Fecal Coliform
107.050	001	SM9221E	Fecal Coliform with Chlorine Present
107.100	001	SM9230B	Fecal Streptococci
107.100	002	SM9230B	Enterococci
107.242	001	Enterolert	Enterococci
107.245	001	SM9223	E. coli

108 - Inorganic Chemistry of Wastewater

108.090	001	EPA 160.4	Residue, Volatile
108.112	001	EPA 200.7	Boron
108.112	002	EPA 200.7	Calcium

108.112	003	EPA 200.7	Hardness (calc.)
108.112	004	EPA 200.7	Magnesium
108.112	005	EPA 200.7	Potassium
108.112	006	EPA 200.7	Silica
108.112	007	EPA 200.7	Sodium
108.120	001	EPA 300.0	Bromide
108.120	002	EPA 300.0	Chloride
108.120	004	EPA 300.0	Nitrate
108.120	008	EPA 300.0	Sulfate
108.211	001	EPA 351.2	Kjeldahl Nitrogen
108.350	001	EPA 418.1	Total Recoverable Petroleum Hydrocarbons
108.362	001	EPA 420.4	Phenols, Total
108.381	001	EPA 1664A	Oil and Grease
108.385	001	SM2120B	Color
108.390	001	SM2130B	Turbidity
108.410	001	SM2320B	Alkalinity
108.420	001	SM2340B	Hardness (calc.)
108.430	001	SM2510B	Conductivity
108.440	001	SM2540B	Residue, Total
108.441	001	SM2540C	Residue, Filterable
108.442	001	SM2540D	Residue, Non-filterable
108.443	001	SM2540F	Residue, Settleable
108.465	001	SM4500-Cl G	Chlorine
108.470	001	SM4500-CN C	Cyanide, Manual Distillation
108.472	001	SM4500-CN E	Cyanide, Total
108.473	001	SM4500-CN G	Cyanide, amenable
108.480	001	SM4500-F C	Fluoride
108.490	001	SM4500-H+ B	pH
108.498	001	SM4500-NH3 H (18th)	Ammonia
108.510	001	SM4500-NO2 B	Nitrite
108.530	001	SM4500-O C	Dissolved Oxygen
108.531	001	SM4500-O G	Dissolved Oxygen
108.540	001	SM4500-P E	Phosphate, Ortho
108.541	001	SM4500-P E	Phosphorus, Total
108.580	001	SM4500-S= D	Sulfide
108.590	001	SM5210B	Biochemical Oxygen Demand
108.591	001	SM5210B	Carbonaceous BOD
108.602	001	SM5220D	Chemical Oxygen Demand
108.610	001	SM5310B	Total Organic Carbon
108.640	001	SM5540C	Surfactants

109 - Toxic Chemical Elements of Wastewater

109.010	001	EPA 200.7	Aluminum
109.010	002	EPA 200.7	Antimony
109.010	003	EPA 200.7	Arsenic
109.010	004	EPA 200.7	Barium
109.010	005	EPA 200.7	Beryllium
109.010	007	EPA 200.7	Cadmium
109.010	009	EPA 200.7	Chromium
109.010	010	EPA 200.7	Cobalt
109.010	011	EPA 200.7	Copper
109.010	012	EPA 200.7	Iron
109.010	013	EPA 200.7	Lead
109.010	015	EPA 200.7	Manganese
109.010	016	EPA 200.7	Molybdenum
109.010	017	EPA 200.7	Nickel
109.010	019	EPA 200.7	Selenium
109.010	021	EPA 200.7	Silver
109.010	023	EPA 200.7	Thallium
109.010	024	EPA 200.7	Tin
109.010	026	EPA 200.7	Vanadium
109.010	027	EPA 200.7	Zinc
109.020	001	EPA 200.8	Aluminum
109.020	002	EPA 200.8	Antimony
109.020	003	EPA 200.8	Arsenic
109.020	004	EPA 200.8	Barium
109.020	005	EPA 200.8	Beryllium
109.020	006	EPA 200.8	Cadmium
109.020	007	EPA 200.8	Chromium
109.020	008	EPA 200.8	Cobalt
109.020	009	EPA 200.8	Copper
109.020	010	EPA 200.8	Lead
109.020	011	EPA 200.8	Manganese
109.020	012	EPA 200.8	Molybdenum
109.020	013	EPA 200.8	Nickel
109.020	014	EPA 200.8	Selenium
109.020	015	EPA 200.8	Silver
109.020	016	EPA 200.8	Thallium
109.020	017	EPA 200.8	Vanadium
109.020	018	EPA 200.8	Zinc
109.020	020	EPA 200.8	Gold
109.020	021	EPA 200.8	Iron
109.020	022	EPA 200.8	Tin

109.020	023	EPA 200.8	Titanium
109.104	001	EPA 218.6	Chromium (VI)
109.400	001	SM3112B	Mercury
109.811	001	SM3500-Cr D (18th/19th)	Chromium (VI)
110 - Volatile Organic Chemistry of Wastewater			
110.040	040	EPA 624	Halogenated Hydrocarbons
110.040	041	EPA 624	Aromatic Compounds
110.040	042	EPA 624	Oxygenates
110.040	043	EPA 624	Other Volatile Organics
111 - Semi-volatile Organic Chemistry of Wastewater			
111.101	030	EPA 625	Pesticides
111.101	031	EPA 625	PCBs
111.101	032	EPA 625	Polynuclear Aromatic Hydrocarbons
111.101	033	EPA 625	Adipates
111.101	034	EPA 625	Phthalates
111.101	036	EPA 625	Other Extractables
111.170	030	EPA 608	Organochlorine Pesticides
111.170	031	EPA 608	PCBs
111.273	001	EPA 1664A	Oil and Grease
114 - Inorganic Chemistry of Hazardous Waste			
114.010	001	EPA 6010B	Antimony
114.010	002	EPA 6010B	Arsenic
114.010	003	EPA 6010B	Barium
114.010	004	EPA 6010B	Beryllium
114.010	005	EPA 6010B	Cadmium
114.010	006	EPA 6010B	Chromium
114.010	007	EPA 6010B	Cobalt
114.010	008	EPA 6010B	Copper
114.010	009	EPA 6010B	Lead
114.010	010	EPA 6010B	Molybdenum
114.010	011	EPA 6010B	Nickel
114.010	012	EPA 6010B	Selenium
114.010	013	EPA 6010B	Silver
114.010	014	EPA 6010B	Thallium
114.010	015	EPA 6010B	Vanadium
114.010	016	EPA 6010B	Zinc
114.020	001	EPA 6020	Antimony
114.020	002	EPA 6020	Arsenic
114.020	003	EPA 6020	Barium
114.020	004	EPA 6020	Beryllium
114.020	005	EPA 6020	Cadmium

114.020	006	EPA 6020	Chromium
114.020	007	EPA 6020	Cobalt
114.020	008	EPA 6020	Copper
114.020	009	EPA 6020	Lead
114.020	010	EPA 6020	Molybdenum
114.020	011	EPA 6020	Nickel
114.020	012	EPA 6020	Selenium
114.020	013	EPA 6020	Silver
114.020	014	EPA 6020	Thallium
114.020	015	EPA 6020	Vanadium
114.020	016	EPA 6020	Zinc
114.103	001	EPA 7196A	Chromium (VI)
114.106	001	EPA 7199	Chromium (VI)
114.140	001	EPA 7470A	Mercury
114.141	001	EPA 7471A	Mercury
114.221	001	EPA 9012A	Cyanide, Total
114.230	001	EPA 9034	Sulfides, Total
114.240	001	EPA 9040B	Corrosivity - pH Determination
114.241	001	EPA 9045C	Corrosivity - pH Determination
114.270	001	EPA 9214	Fluoride
115 - Extraction Test of Hazardous Waste			
115.020	001	EPA 1311	Toxicity Characteristic Leaching Procedure (TCLP)
115.030	001	CCR Chapter11, Article 5, Appendix II	Waste Extraction Test (WET)
115.040	001	EPA 1312	Synthetic Precipitation Leaching Procedure (SPLP)
116 - Volatile Organic Chemistry of Hazardous Waste			
116.010	000	EPA 8011	EDB and DBCP
116.030	001	EPA 8015B	Gasoline-range Organics
116.080	000	EPA 8260B	Volatile Organic Compounds
116.080	120	EPA 8260B	Oxygenates
116.100	002	LUFT GC/MS	Benzene
116.100	003	LUFT GC/MS	Toluene
116.100	004	LUFT GC/MS	Xylenes
116.100	005	LUFT GC/MS	Methyl tert-butyl Ether (MTBE)
116.100	010	LUFT GC/MS	BTEX and MTBE
116.110	001	LUFT	Total Petroleum Hydrocarbons - Gasoline
117 - Semi-volatile Organic Chemistry of Hazardous Waste			
117.010	001	EPA 8015B	Diesel-range Total Petroleum Hydrocarbons
117.016	001	LUFT	Diesel-range Total Petroleum Hydrocarbons
117.017	001	EPA 418.1	TRPH Screening
117.110	000	EPA 8270C	Extractable Organics
117.111	076	EPA 8270C	Other Extractables

As of 12/24/2010, this list supersedes all previous lists for this certificate number.
Customers: Please verify the current accreditation standing with the State.

117.210	000	EPA 8081A	Organochlorine Pesticides
117.220	000	EPA 8082	PCBs
117.240	000	EPA 8141A	Organophosphorus Pesticides
117.250	000	EPA 8151A	Chlorinated Herbicides

120 - Physical Properties of Hazardous Waste

120.010	001	EPA 1010	Ignitability
120.070	001	EPA 9040B	Corrosivity - pH Determination
120.080	001	EPA 9045C	Corrosivity - pH Determination

CDPH
California Department of
PublicHealth

CALIFORNIA STATE

ENVIRONMENTAL LABORATORY ACCREDITATION PROGRAM BRANCH

CERTIFICATE OF ENVIRONMENTAL ACCREDITATION

Is hereby granted to

EDWARD S. BABCOCK & SONS, INC.

6100 & 6110 QUAIL VALLEY COURT

RIVERSIDE, CA 92507

Scope of the certificate is limited to the
"Fields of Testing"
which accompany this Certificate.

Continued accredited status depends on successful completion of on-site, proficiency testing studies, and payment of applicable fees.

This Certificate is granted in accordance with provisions of Section 100825, et seq. of the Health and Safety Code.

Certificate No.: **2698**

Expiration Date: **05/31/2012**

Effective Date: **05/01/2010**

George C. Kulasingam

Richmond, California
subject to forfeiture or revocation

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

State of California—Health and Human Services Agency
California Department of Public Health

MARK B HORTON, MD, MSPH
Director

ARNOLD SCHWARZENEGGER
Governor

May 3, 2010

LAWRENCE CHRYSTAL
EDWARD S. BABCOCK & SONS, INC.
PO BOX 432
RIVERSIDE, CA 92502-0432

Dear LAWRENCE CHRYSTAL: Certificate No. 2698

This is to advise you that the laboratory named above continues to be certified as an environmental testing laboratory pursuant to the provisions of the Health and Safety Code (HSC), Division 101, Part 1, Chapter 4, Section 100825, et seq. Certification for all currently certified Fields of Testing that the laboratory has applied for renewal shall remain in effect until **05/31/2012** unless it is revoked.

Please note that the renewal application for certification is subject to an on-site process, and the continued use of this certificate is contingent upon:

- **successful completion of the on-site process;**
- **acceptable performance in the required proficiency testing (PT) studies;**
- **timely payment of all fees, including an annual fee due before May 31, 2011;**
- **compliance with Environmental Laboratory Accreditation Program Branch (ELAP) statutes (HSC, Section 100825, et seq.) and Regulations (California Code of Regulations (CCR),Title 22, Division 4, Chapter 19).**

An updated certificate of the "Fields of Testing" will be issued to the laboratory upon successful completion of the on-site process.

The application for the renewal of this certificate must be received before the expiration date to remain in force according to the HSC100845(a).

Please note that the laboratory is required to notify ELAP of any major changes in the laboratory such as the transfer of ownership, change of laboratory director, change in location, or structural alterations which may affect adversely the quality of analyses (HSC, Section 100845(b)(d)). Please include the above certificate number in all your correspondence with ELAP.

If you have any questions, please contact ELAP at (510) 620-3155.

Sincerely,

George C. Kulasingam, Ph.D., Chief
Environmental Laboratory Accreditation Program Branch

Appendix B Equipment List & Facility Maps

E.S. BABCOCK & SONS, INC. LIST OF EQUIPMENT

I. Major Instrumentation

Equipment/ Instrument	# of Units	Maintenance Logbook Number	Manufacturer	Year Purchased	Model Number/ Misc. Info.
LC/MS/MS	2	163	Varian,Thermo Scientific	2004, 2010	Varian1200, Thermo Scientific
Discrete Automated Analyzer	1	196	Seal	2005	AQ2e
Gas Chromatograph	3	32 33 131	Hewlett-Packard/Agilent	1989, 2001, 2003	5890 ECD+ECD 6890 ECD/ECD 6890N ECD/ECD
Gas Chromatograph	1	213	Varian	2006	CP-3800 ECD/ECD
Gas Chromatograph	1	35	Hewlett-Packard	1989	5890 FID+NPD
Gas Chromatograph	1	137	Agilent	2003	6890 FID & NPD
Gas Chromatograph	1	34	SRI	1999	310 TCD
GC/MS	4	28, 29, 39,40	Hewlett-Packard/Agilent	1999, 2000 1998, 2001	6890-5973
GC/MS-Ion Trap	1	115	Varian	2001	2100T/ Saturn
GC/MS/MS	1	207	Varian	2006	4000
HPLC	1	31	Pickering	1997	1100 UV/VIS and Fluorescence
ICP	2	199, 200	Perkin-Elmer	2005, 2010	Optima 5300DV, Optima 7000 DV
ICP/MS	1	47	Perkin-Elmer	2010	Elan 9000
ICP/MS	1	198	Perkin-Elmer	2005	Elan DRCe 9000
Infrared Spectrophotometer	1	75	Buck Scientific	2001	HC404
Ion Chromatograph	1	50	Dionex	1996	DX500/ Cond.
Ion Chromatograph	1	83	Dionex	2001	DX600/Cond. + UV-VIS
Ion Chromatograph	4	49, 114, 59, 37	Dionex	1998/2002/ 2009/2009	DX120-1/DX120-2/Dionex ICS- ICS-2100
Mercury Analyzer	1	41	Perkin-Elmer	1994	FIAS 400
TOC and auto-	1	209	Shimadzu	2006	TOC-Vcsh

sampler					ASI V
TOC Solid Sample Module	1	42	Shimadzu	1998	SSM-5000A
TOX Analyzer	1	203	Analytik Jena	2006	Multi X2000
Turbidimeter	1	52	Hach	1998	2100N
Turbidimeter	1	243	Obeco-Hellige	2009	1102
UV/VIS Spectrophotometer	2	152, 227	Thermospectronic	2004, 2007	Genesys10uv
UV/VIS Spectrophotometer	1	110	Thermospectronic	2002	Spectronic 20D+

II. Accessory Equipment

Equipment/ Instrument	# of Units	Maintenance Logbook Number	Manufacturer	Year Purchased	Model Number/ Misc. Info
ICPMS Autosampler	1	198	Perkin-Elmer	2005	AS-90+
ICP/ICPMS Autosamplers	2	41, 47	Perkin-Elmer	1994, 2010	AS-90
Analytical Balance	2	141, 226	A.N.D.	2007/2003	HR-200
Analytical Balance	2	64, 179	Ohaus	2001	Adventurer
Analytical Balance	3	24, 58, 65	Mettler		9514, AB104, BD1201
Analytical Balance	1	224	Acculab		VICON VIC-212
BOD Incubator	3	56, 57,248	VWR, Sheldon	57: 1998 248:2010	2030 248:2027310
Block Digestor	1	122	Lachat	2001	BD-46
Centrifuge	3	74, 77, 216	Fisher Scientific	216: 2006	Centrific
Chromatography Data Station	2		P.E. Nelson	1995	Turbochrom
Chromatography Data Station	2		P.E. Nelson	2001	Totalchrom
Chromatography Data Station	2	50, 83	Dionex DX500/ Dionex DX600	1996/2001	Peak Net 5.0/Chromeleon Peak Net 6.0
COD Reactor	1	70	Hach	2000	45600
Concentrat. Wkstation	2	138, 222	Zymark	2001, 2006	Turbo Vap II

Conductance Meter	2	53, 208	YSI	208: 2006	Model 35 and YSI 3100
Dissolved Oxygen Meter	1	48	YSI	1999	5000
Distiller	1	212	Environmental Express	2006	Enviro-Midi
Distiller	1	210	Glas-Col		Combo Mantle
Evaporation System	1	140	Horizon	2003	Speed-Vap II 9000
Flash Point Apparatus	1	79	Koehler	2009	Serial # RO7002115
Fluoride Meter	1	247	VWR	2010	SN#D04972
Gravity Ovens	2	67, 68	VWR	67: 1998	1370G
Heat Block	2	220, 249	Environmental Express	2007, 2008	Autoblock II
HPLC UV Detector	1	31	Hewlett-Packard	1997	G1314A
ICP Autosampler	1	199	Perkin-Elmer	2005	AS-93 plus
Liquid Autosampler	2	32, 33	Hewlett-Packard/ Agilent	1989, 2001	6890 Series G1513A
Liquid Autosampler	4	28, 29, 131, 137	Agilent	1999, 1989, 2003, 2003	7683 Series
Liquid Autosampler	1	49	Alcott	1998	728
Liquid Autosampler	2	50, 114	Alcott	1996, 2002	708
Liquid Autosampler	1	163	Varian	2004	Prostar 410
Liquid Autosampler	1	83	Dionex	2001	AS-50
Liquid Autosampler	1	213	Varian	2006	CP3800
Liquid Autosampler	1	207	Varian	2006	CP8400
Midi-Distiller	2	113, 242	Glastron	2001, 2010	Serial # 2004, #2265
Muffle Furnace	2	5, 10	Lindburg	2001 & 2011	BF51894/BF51694 & P16W-528121-PW
pH Meter		3, 54	Symphony Orion,	2011,1995,	C03181,SA720, C02235

Portable pH meter	1	162, 250	VWR, VWR Symphony	2004, 2010	SP21, SNTX282A
Thermal Desorption Unit	1	36	Perkin Elmer	1999	ATD-400
Purge and Trap Units	1		OI Analytical		4460A
Purge and Trap Units	2	35	OI Analytical	1989	4560
Purge and Trap Units	2	40, 115	Tekmar	2000, 2001	LSC-3100
Purge & Trap unit	1	39	Estencon	1998	Encon (Archon)
Sep. Funnel Shaker	1	204	Eberbach	2003	6010
TCLP/WET Extraction	1	150	Dayton Motor Driven		30 rpm
TCLP/ZHE Extraction Apparatus	1	145	Gelman	1990	Serial # 1353
Ultrasonic Cleaner	1	117	Branson		2510
Ultra-Sonic Disrupter	2	246, 254	Branson	2010/2010	Sonifier 450
VOA Autosampler	1	35	OI Analytical	1989	4551
VOA Autosampler	1		Precision/Dynatech		PT-30/PT-30ws
VOA Autosampler	3	39, 40, 115	Varian	1998, 2000, 2001	Archon
Vortex Mixer	2		VWR		Vortexer 2
Wristshaker	2	154, 177	Burrell Scientific	2004, 2002	#75
Water Baths	2	69, 76	Henry's Welding	2000	
Water Purifier	2	55	Barnstead		NanoPure-UV D7334

III. Microbiology Equipment

Equipment/ Instrument	**# of Units**	**Maintenance Logbook Number**	**Manufacturer**	**Model Number/ Misc. Information**
Autoclave	3	132, 146, 225	Market Forge	STM-EL
Mini Vidas	1	27	Biomerieux	SN#IVD1208415
Recording Thermometer/Chart	3	9,148 , 158	United Electric Controls,	UE650

Recorder			CoBex	
Fecal Water Bath	2	11, 159	Precision	P-128
Colony Counter	1	82	Darkfield Quebec	3330
Agar Bath	4	161,236, 244, 245	VWR, Fisher Scientific Shel Lab	124OT (2at 229), Serial#8100804 1603080506791 2043210,2043510
Incubators	9	2,18-23, 144, 211	VWR	Various
pH Meter	1	6	VWR	D06214
DI Water Purifier	1	25	Barnstead	Diamond
Unispense	2	13, 14	Wheaton	
Balance	1	24	Mettler Toledo	
Dry Oven Temperature Recorder	1	235	Dickson	KT601
Dry Oven	1	15	Fischer Scientific	600 Series SN 607443-35
Quanti-Tray Sealer	2	234,241	IDEXX	2X-89-10894-00, 2X-89-10894-04
Dissecting Scope	1	26	Unitron	
Bacti Fridge	1	136	Whirlpool	UO5291418

IV. Field Department Equipment

Equipment/ Instrument	**# of Units**	**Maintenance Logbook Number**	**Manufacturer**	**ModelNumber/ Misc. Information**
Composite Samplers	2	88,186	Isco	2700
Composite Samplers	1	96	Isco	2910
Composite Samplers	4	89,183,184,191	Isco	3700
Composite Samplers	5	229, 230, 231, 232, 233	Isco	6712
Composite Samplers	2	164,165	Isco	6700
Gas Detector	1	180	Gas Tech	GT 402
Flow Meters	7	106, 107, 166, 167, 193, 194, 195	Isco	3210
Flow Meters	2	103,104	Isco	4210
pH meter	2	149, 206	VWR	SP-20, SP-21
pH meter	2	147, 215	Beckman	240
pH meter	2	251,252	VWR	SP70P
Dissolved Oxygen meter	1	156	YSI	550A

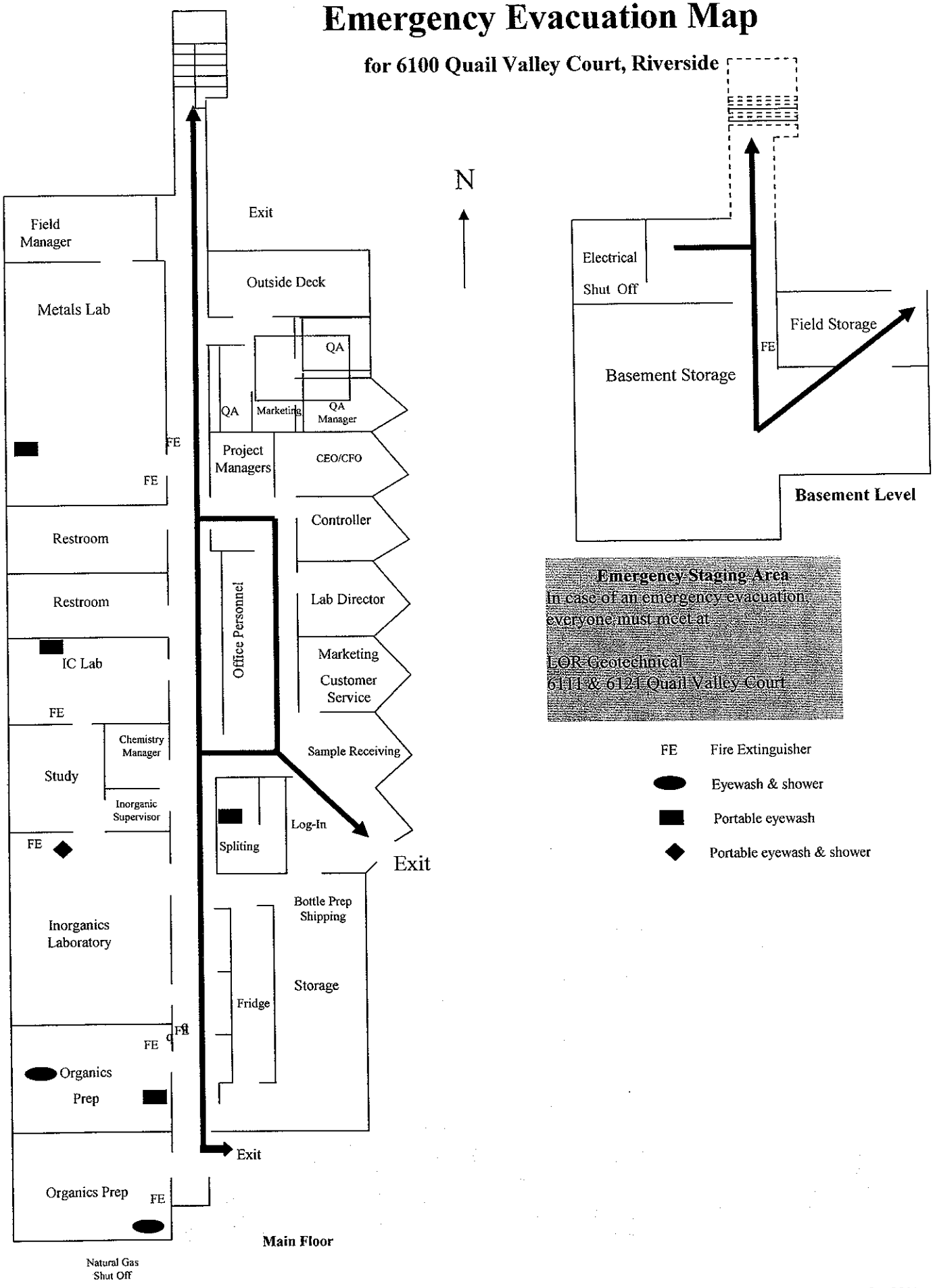
Chlorine Pocket Colorimeter	3	239, 240,253	Hach	
Portable Conductivity Meter	1	181	Hach	51975-00

Updated 5/2/2011 SF

E.S. Babcock & Sons

Emergency Evacuation Map

for 6100 Quail Valley Court, Riverside



Emergency Staging Area
In case of an emergency evacuation, everyone must meet at

LOR Geotechnical
6111 & 6121 Quail Valley Court

FE Fire Extinguisher

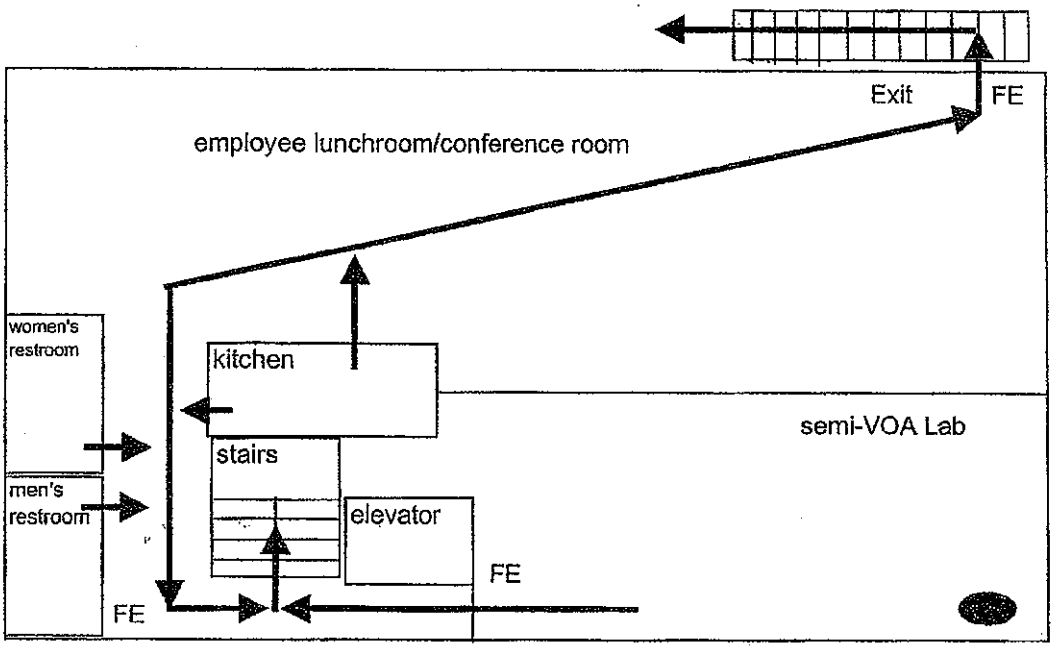
Eyewash & shower

Portable eyewash

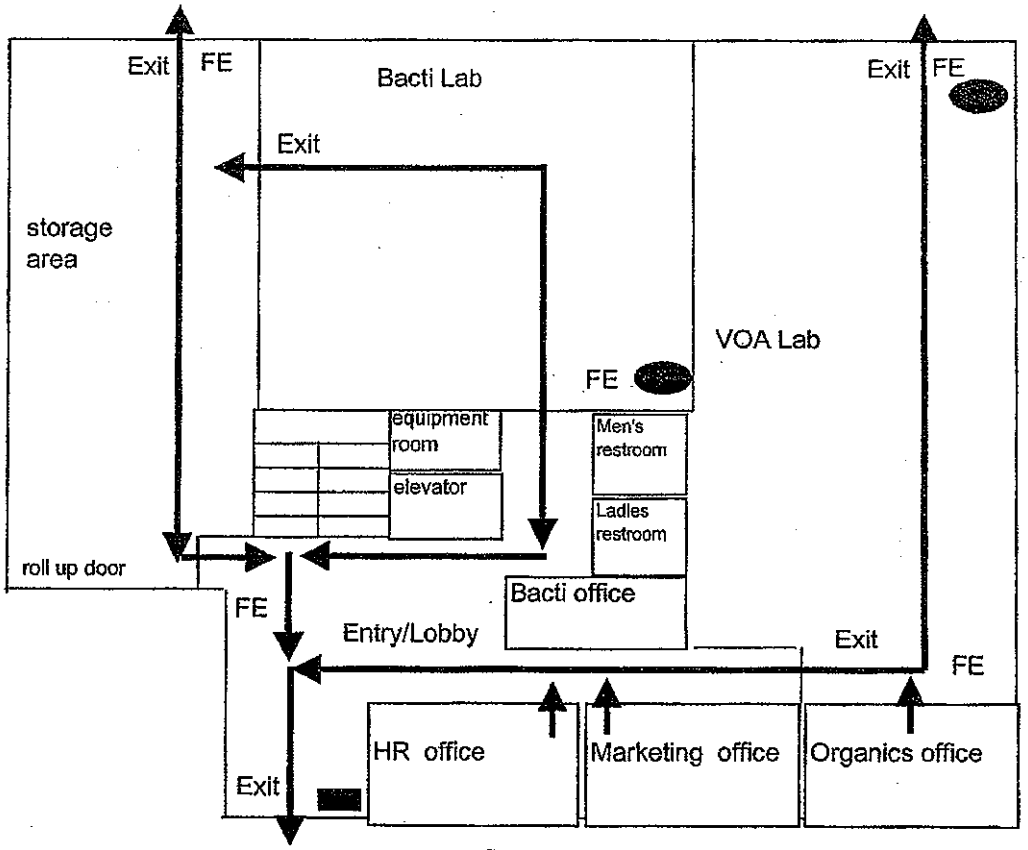
Portable eyewash & shower

Jan 2011

Emergency Evacuation Map
for 6110 Quail Valley Court



Upstairs at 6110 Quail Valley Court



Downstairs at 6110 Quail Valley Court

fire alarm pull box

eye wash/shower

FE fire extinguisher

Emergency Staging Area

In case of an emergency evacuation, everyone must meet at LOR Geotechnical

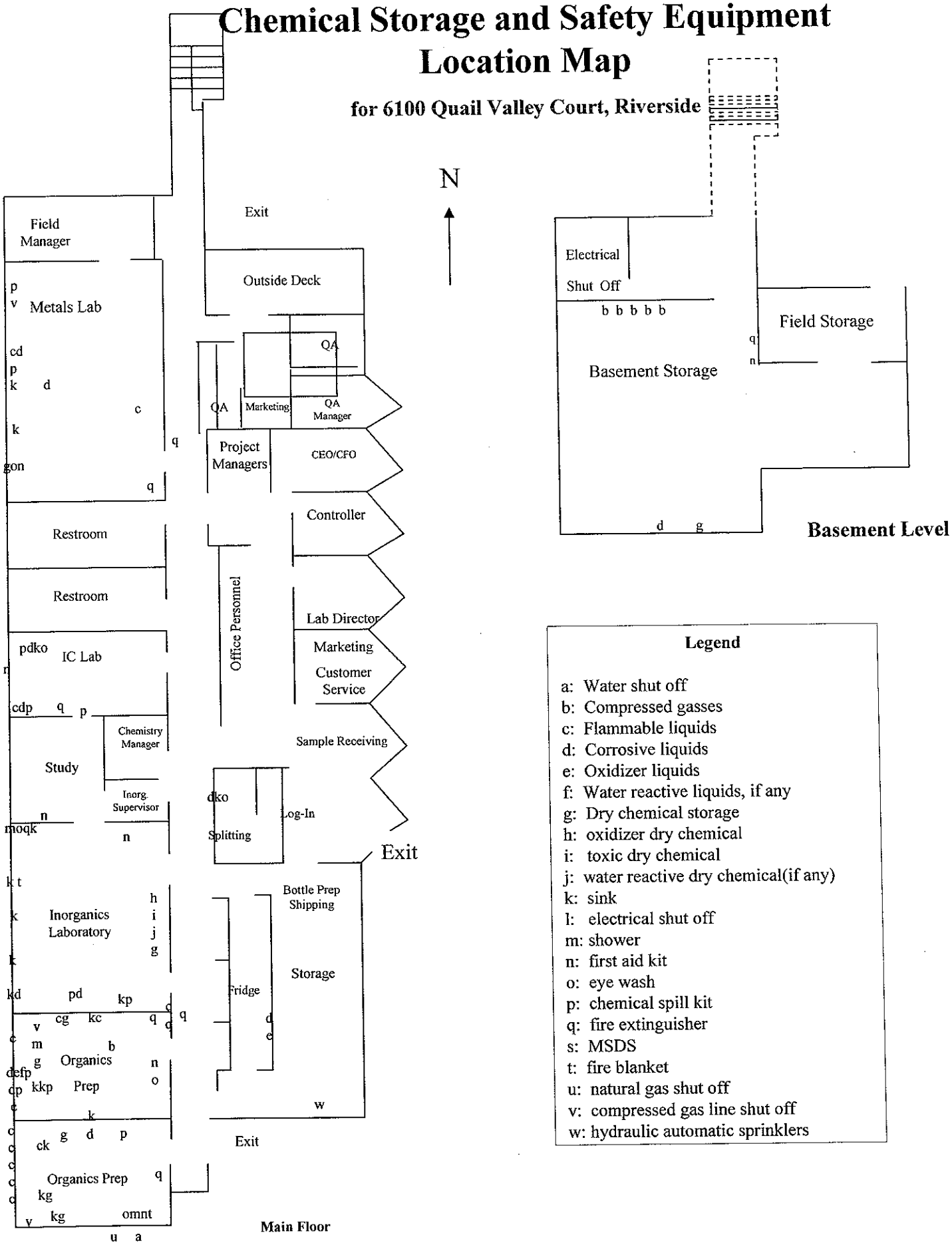
6111 & 6121 Quail Valley Court

15 October 04

E.S. Babcock & Sons

Chemical Storage and Safety Equipment Location Map

for 6100 Quail Valley Court, Riverside



Legend

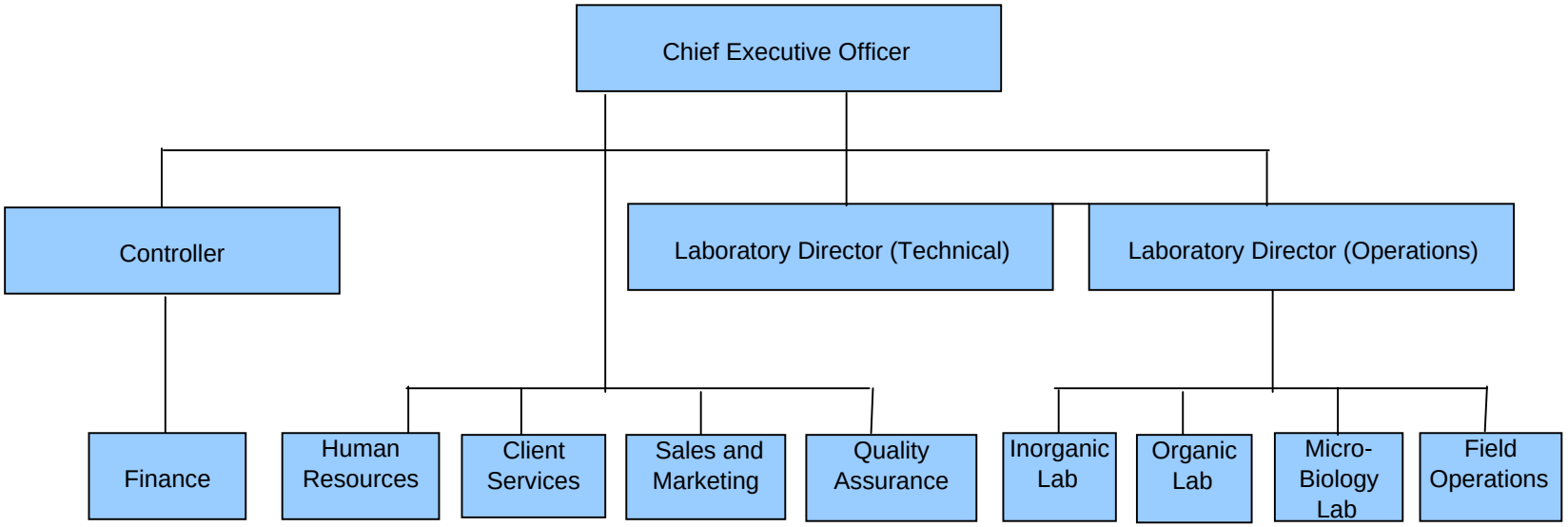
a: Water shut off
b: Compressed gasses
c: Flammable liquids
d: Corrosive liquids
e: Oxidizer liquids
f: Water reactive liquids, if any
g: Dry chemical storage
h: oxidizer dry chemical
i: toxic dry chemical
j: water reactive dry chemical(if any)
k: sink
l: electrical shut off
m: shower
n: first aid kit
o: eye wash
p: chemical spill kit
q: fire extinguisher
s: MSDS
t: fire blanket
u: natural gas shut off
v: compressed gas line shut off
w: hydraulic automatic sprinklers

Jan 2011

Appendix C Organizational Chart

Edward S. Babcock Sons, Inc.

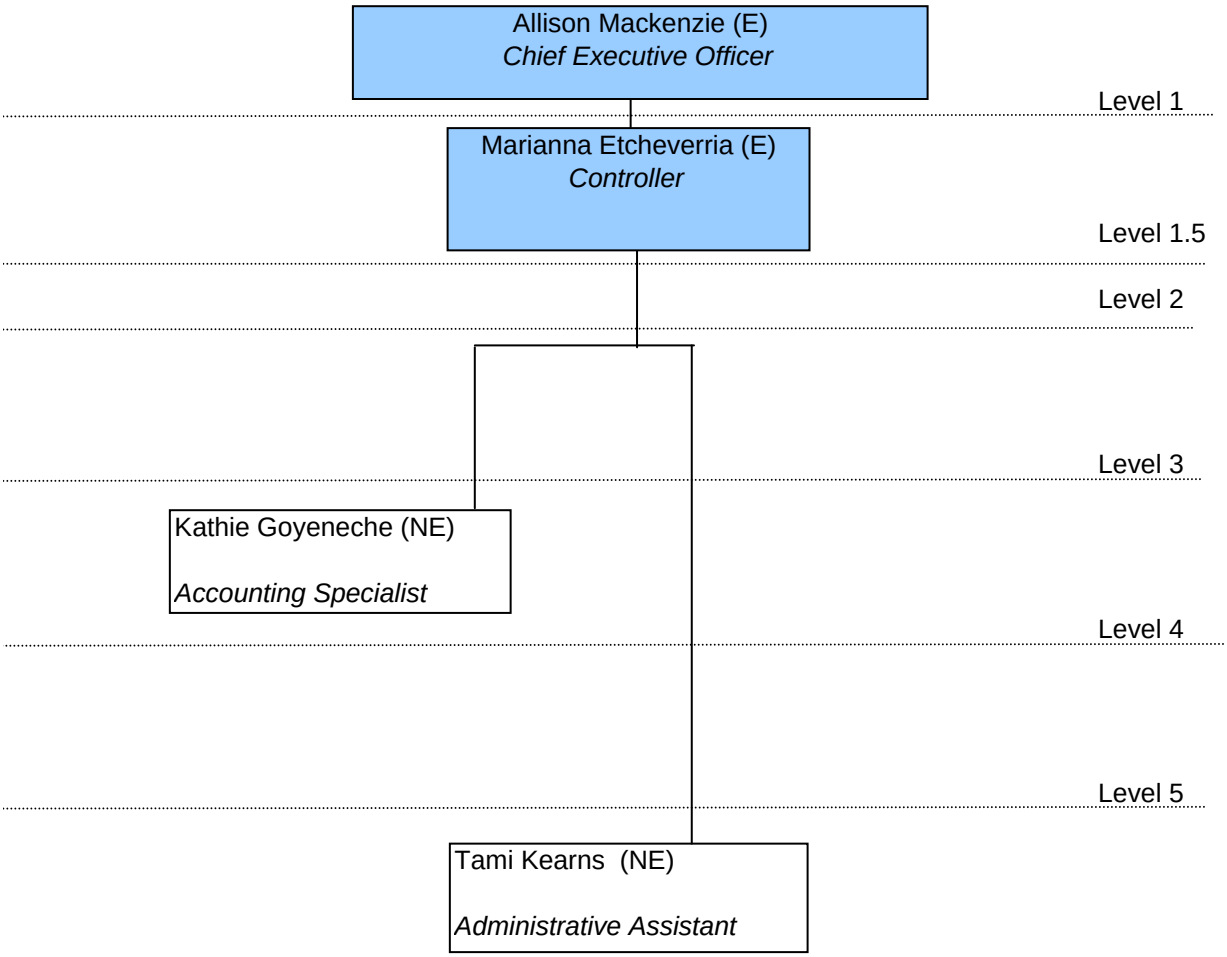
Organizational Chart
Overview



March 18, 2011

Edward S. Babcock & Sons, Inc.

Organizational Chart
Administration



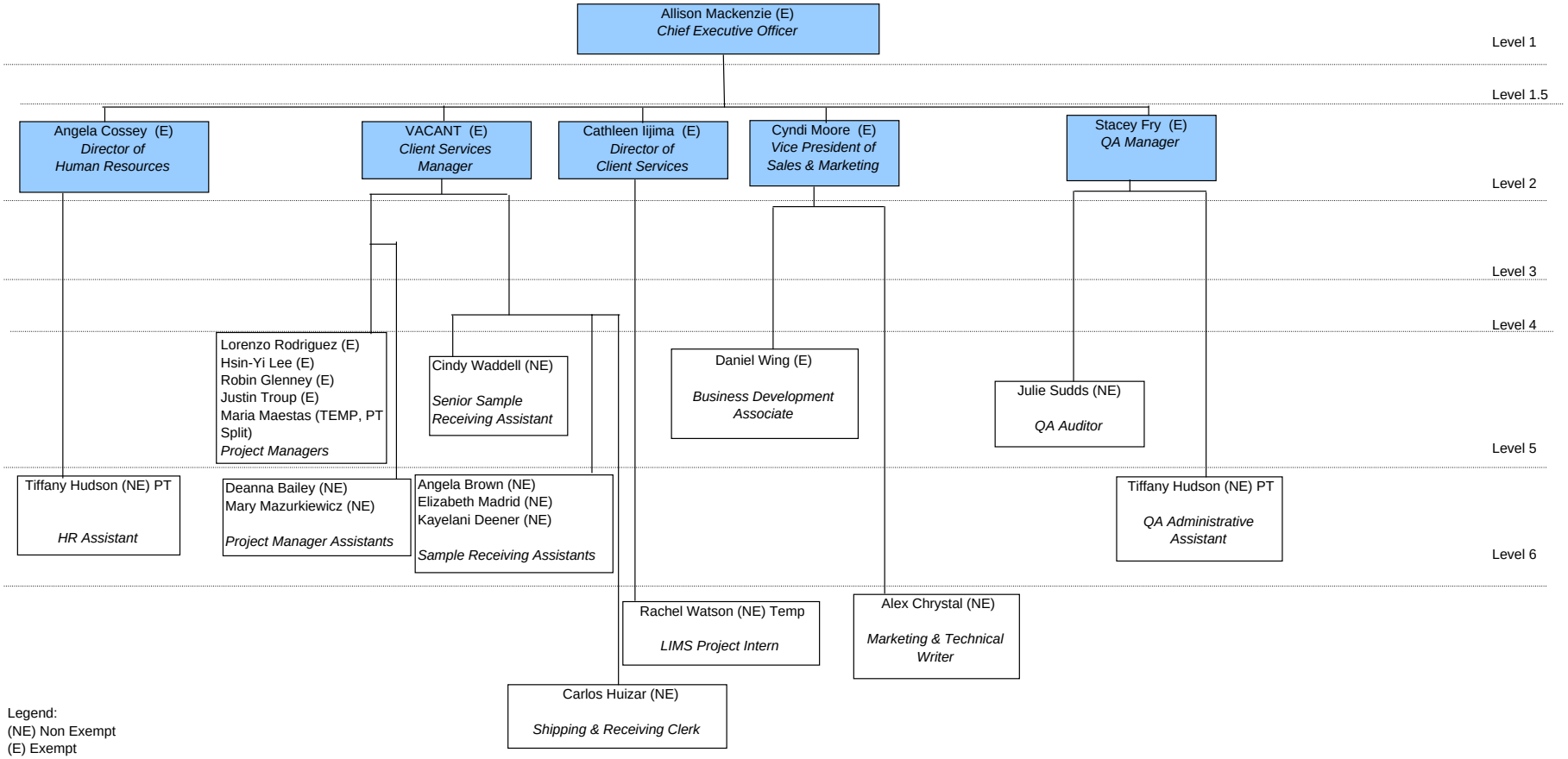
Legend:
(NE) Non Exempt
(E) Exempt
(TEMP) Temporary

Level 7

May 9, 2011

Edward S. Babcock & Sons, Inc.

Organizational Chart
Administration

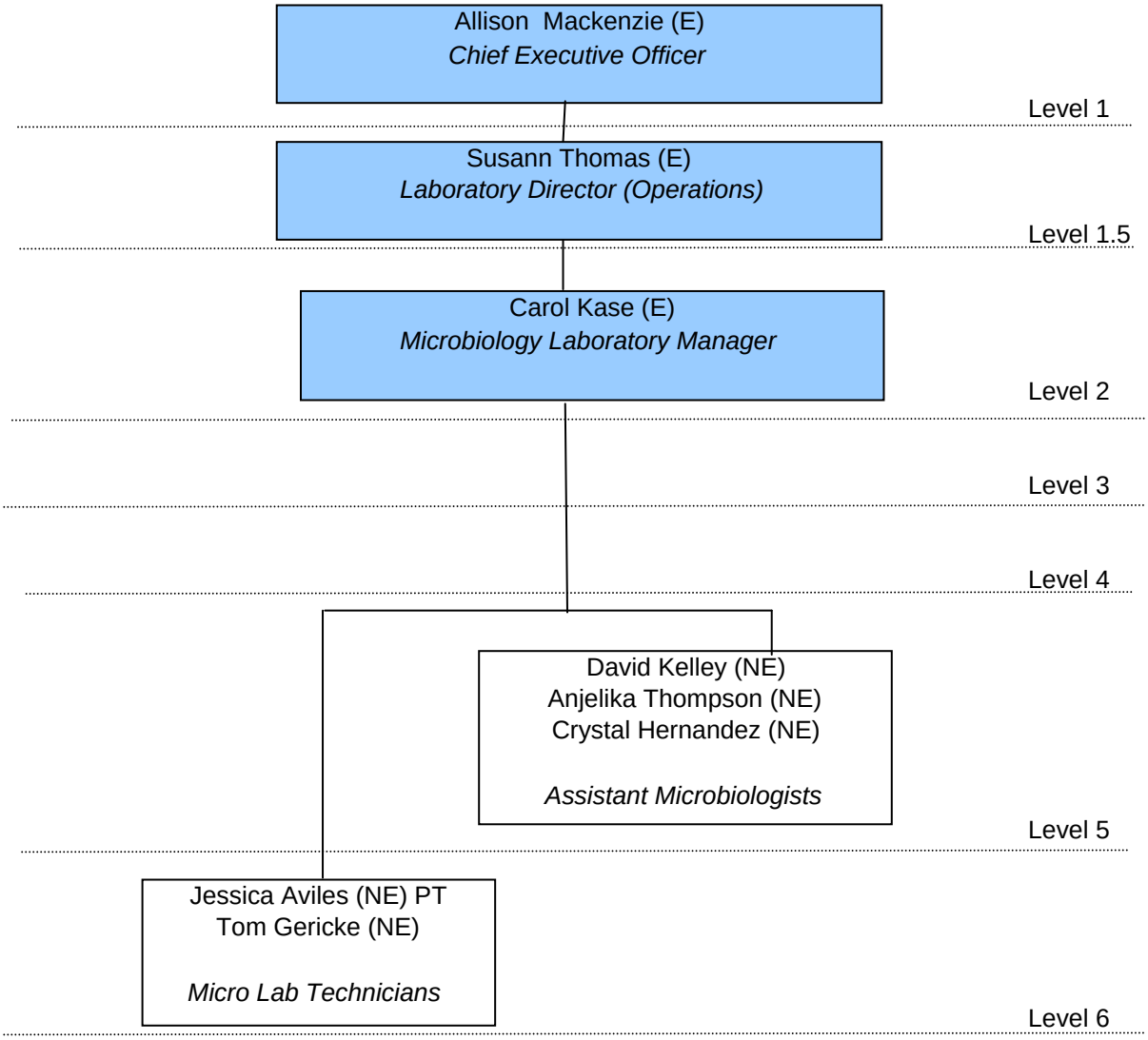


Legend:
(NE) Non Exempt
(E) Exempt
(TEMP) Temporary

June 28, 2011

Edward S. Babcock & Sons, Inc.

Organizational Chart
Bacti Department



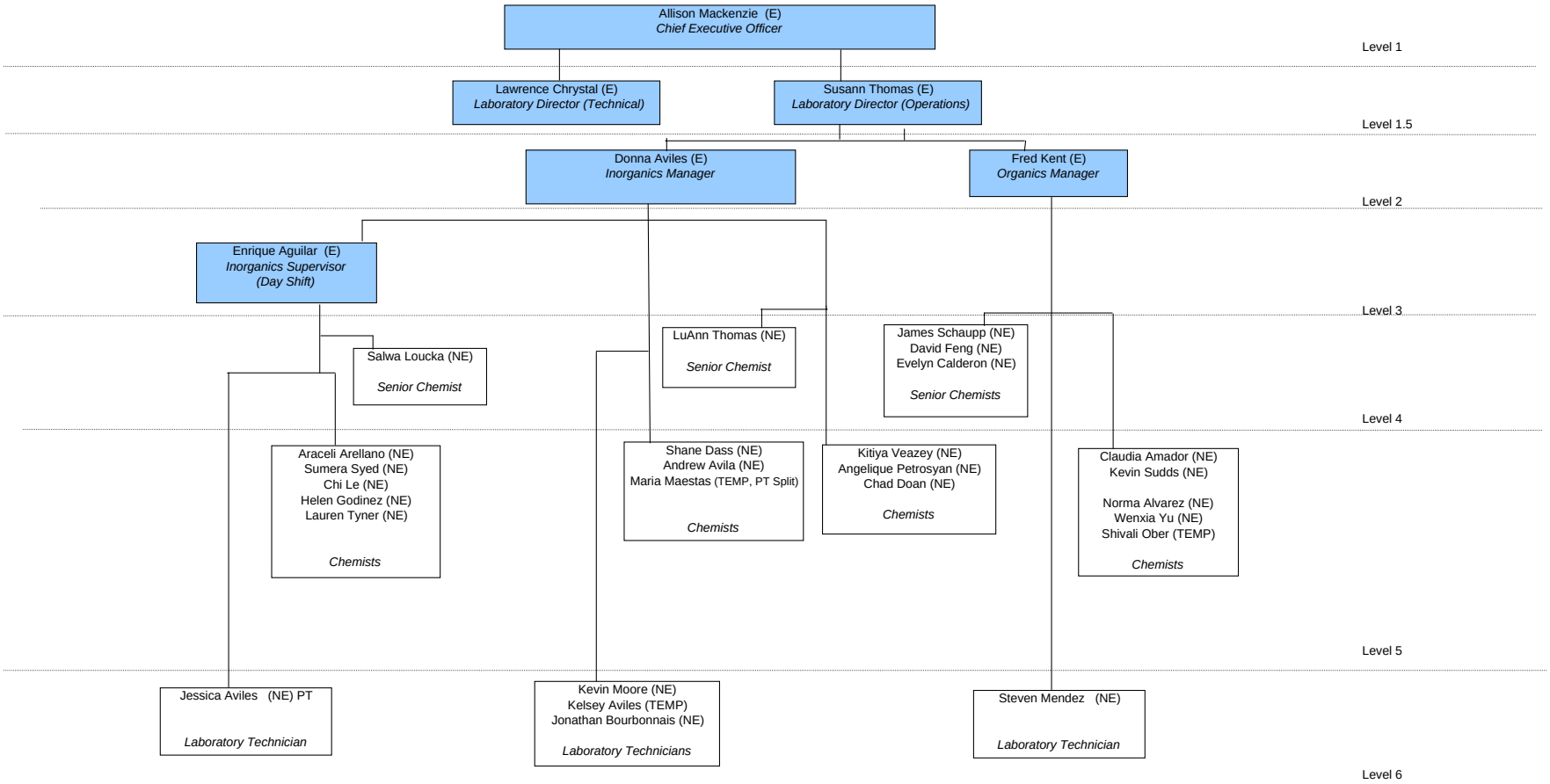
Legend:
(NE) Non Exempt
(E) Exempt
(TEMP) Temporary

Level 7

May 9, 2011

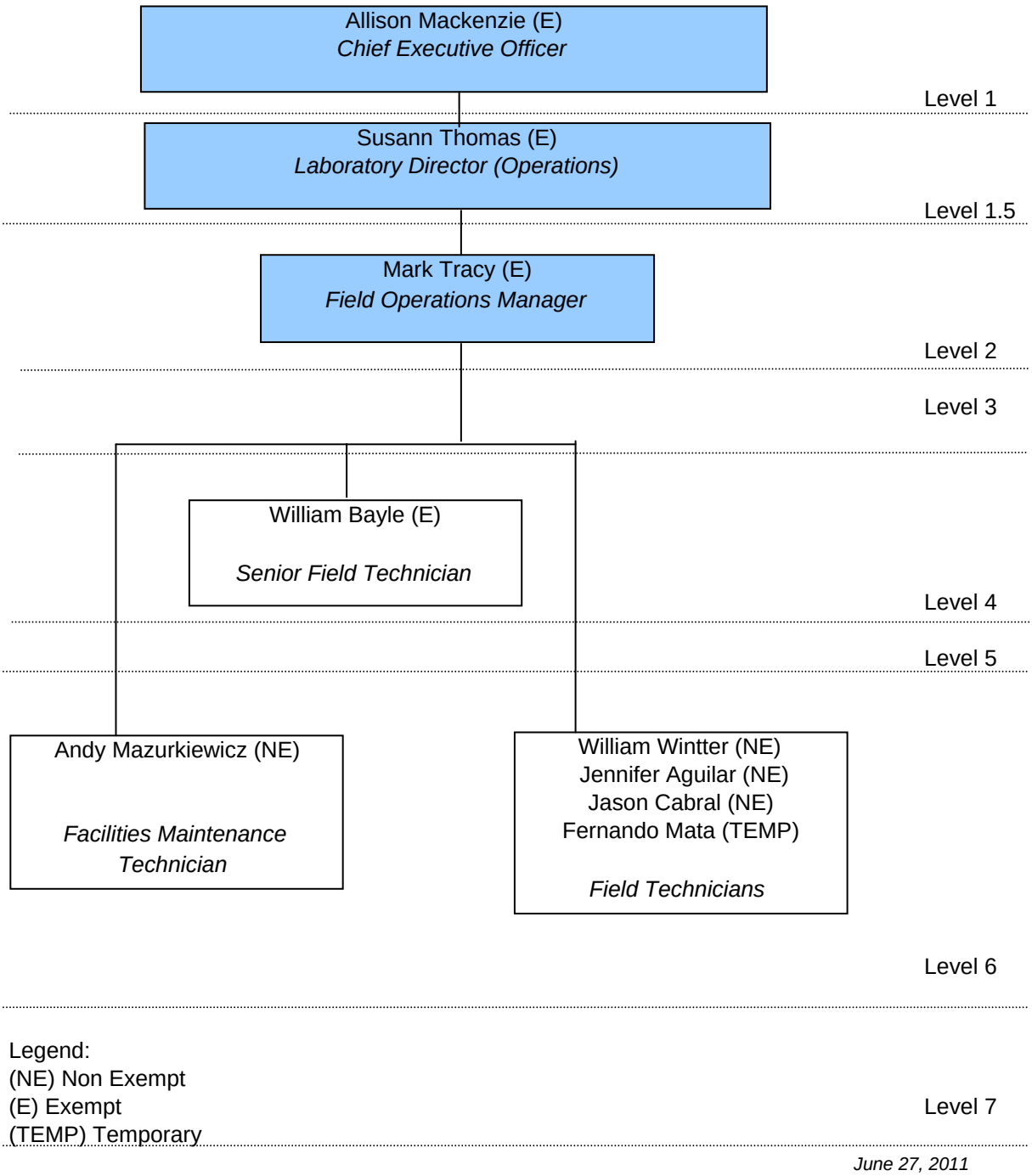
Edward S. Babcock & Sons, Inc.

Organizational Chart
Chemistry Department



Edward S. Babcock & Sons, Inc.

Organizational Chart
Field Department



Legend:
(NE) Non Exempt
(E) Exempt
(TEMP) Temporary

June 27, 2011

Appendix D Resumes of Key Personnel

Resumes of Key Personnel - available upon request

Lawrence Chrystal
Allison Mackenzie
Marianna Etcheverria
Cathleen Iijima
Cyndi Moore
Mark Tracy
Stacey Fry
Carol Kase
Susann Thomas
Angela Cossey
Donna Aviles
Enrique Aguilar
Fred Kent
William Bayle
Julia Sudds
LuAnn Thomas
James Schaupp
Dr. David Feng
Lorenzo Rodriguez
Robin Glenney
Hsin-Yi Lee
Justin Troup

RESUME

Allison Mackenzie, CEO/CFO

Education:

B.A. Biology, 1978 - University of California, Riverside, CA. Secondary Teaching Credential in Chemistry & Physics, 1985 - University of California, Riverside, CA.

Professional Experience:

Ms. Mackenzie has over 30 years of experience in the environmental laboratory business, including 20 years as Vice President and General Manager of ESB, and 8 years in analytical method development for both inorganic and organic determinations in drinking water and wastewater. Ms. Mackenzie is currently the senior executive, responsible for policy objectives and strategy for the operation and expansion of the business, including the development of operating budgets, sales and profitability targets, product development, quality assurance and the development and retention of customer relationships.

Training:

Geology Series: Groundwater and Related Issues, UCR Extension (2007)
Perchlorate Regulation in California, ES Babcock & Sons, Inc. (2005)
CEO Management Training Program, Estrada Strategies (2004-2005)
Advanced Management Program, UCR (2001)
Hexavalent Chromium in Groundwater, GRA (2001)
ICR Workshop, AWWA (1996)
LIMS Implementation, ACS (1994)
SB-1841 Regulations and Liabilities, Setting Up an Emergency Operations Center, AWWA (1994)
Human Resources Management Techniques, UCR (1991)

Presentations:

"Current Laboratory Techniques for the Determination of CECs", CWEA Annual Conference, Ontario, CA April, 2011.
"Santa Ana Watershed Emerging Constituents Investigation: Sampling and Lab Analysis Plan ", ESB TEAM Presentation, March, 2010.
"Storm Water Issues: Changes, Challenges, Solutions", Rain For Rent, May, 2009
"Your Environmental Laboratory: A Partnership in Protecting the Public Health", Inland Counties Water Agencies, Nov., 2008.
"Evaluating and Working With Your Laboratory" sponsored by the California Rural Water Association, 1997.
"Update on General Stormwater Permit" sponsored by California Regional Water Quality Control Board, Santa Ana Region, 1996.
"NPDES General Permit for Storm Water Discharges Associated with Industrial Activities and the Storm Water Sampling Plan" E.S. Babcock & Sons, Inc., in association with the California Regional Water Quality Control Board, Santa Ana Region, 1995.
"Careers for Women in the Environmental Field" UCR, 1994.

Awards:

'2010 Spirit of the Entrepreneur Award', Inland Empire Center for Entrepreneurship, California State University, San Bernardino.

Associations:

Advisory Board Member of Water Resources Institute, CSU San Bernardino
American Association for University Women (AAUW)
American Council of Independent Laboratories (ACIL)
American Water Works Association (AWWA)
California Water Environment Association (CWEA)
Groundwater Resources Association of California (GRA)
Rotary Club of Riverside, Rotary International
United Way of the Inland Valleys, Board Member

RESUME

Angela Cossey, PHR, Director of Human Resources

Education:

PHR, Professional in Human Resources – Claremont Graduate School
Master of Science Administration – Pepperdine University, Malibu, CA
Bachelor of Arts Language - University of California, Riverside, CA.

Professional Experience:

Since 2002, Ms. Cossey has been responsible for a full range of HR functions including development of HR plans and programs. She is extensively involved with employee relations, leadership and organizational development, employment and regulatory issues as well as compensation & benefits.

Training:

Certificate in Human Resource Management – Employer's Group

Professional Accomplishments:

- Successfully developed, implemented and managed all aspects of human resources to support growth and business objectives.
- Developed and implemented an effective recruiting strategy & new hire orientation program
- Designed & implemented a new benefits program

Associations:

Society for Human Resource Management (SHRM)
Employer's Group

RESUME

Carol Kase, Microbiologist - Microbiology Laboratory Manager

Education:
B.S. Biology, 1986, University of California, Riverside, CA, A.S. Chemistry, 1983, San Bernardino Valley College, San Bernardino, CA

Professional Experience:
Ms. Kase has worked extensively with microbiological determinations since her employment began with E.S. Babcock & Sons, Inc. in 1984. With over 26 years of experience in the environmental laboratory field, Ms. Kase has a comprehensive knowledge of all aspects of the Microbiological Department. She is accountable for the analysis of drinking water and wastewater to determine the presence and densities of coliform bacteria, fecal coliform, *E. coli*, fecal streptococcus, enterococcus, pseudomonas, iron bacteria and the speciation of coliform bacteria. *E. coli* determinations are also made on soils and sludges. She is proficient with Element and LIMS systems.

Adherence to state and federal guidelines is maintained at all times as well as quality control for media preparations, instrumentation, and procedures. Ms. Kase is in constant contact with State and County Health Departments, municipalities, local water companies and private customers providing time-sensitive bacteriological results.

Ms. Kase has been instrumental in the restructure and readiness of the Bacteriological Department for the NELAP/ELAP audits. She has developed an excellent reputation for her professionalism and outstanding performance, and has been frequently requested by the Riverside County Health Department, San Diego State Health Department and the Southern California Coastal Water Research Project to handle special projects. Ms. Kase is also responsible for the supervision of four assistants.

Prior to her work at Edward S. Babcock & Sons, Inc., Ms. Kase was a laboratory technician at San Bernardino Valley College in the Chemistry Department.

Additional Training:
Mini-Vidas training, Riverside, CA, 4/16/2011
Basic Food Safety Microbiology, Las Vegas, NV, 4/04/2011
"The New TNI Laboratory Accreditation Standards", Riverside CA, 7/09/10.
"Recycled Water: Regulatory Reality & Public Expectations", Riverside, CA (2009)
"California Drought Conditions: How Will You Deal with On-Going Water Shortages?", Riverside, CA (2008)
"Endocrine Disruptors (EDCs), Pharmaceuticals & Personal Care Products (PPCPs): Actions, Communications and Prevention", Riverside, CA (2008)
""Drinking Water Regulatory Update – What's Coming Down the Pipeline?" Riverside, CA (2007)
"UCMR 2 Webcast" Riverside, CA (2007)
"2006 Regulatory Drinking Water Overview – With Special Emphasis on the IDSE and Stage 2 DBP Rule" Riverside, CA (2006)

"EPA Webcast – Overview of Two Recently Promulgated Rules: Stage 2 Disinfectants & Disinfection By Products Rule" Riverside, CA (2006)
"Water Quality Sampling Guidelines for Drinking Water and Wastewater – A Crash Course" Riverside, CA (2006)
"Stormwater Runoff in Southern California: Regulation, Compliance and Determination" Riverside, CA (2005)
"Bacteria in Drinking Water: Everything You Always Wanted To Know But Were Afraid To Ask" Riverside, CA (2005)
"Perchlorate in Southern California: Regulation, Remediation and Determination" Riverside, CA (2005)
"The Six Disciplines of Business" Estrada Strategies, CEO Teleconference, Riverside, CA (2005, 2006, 2007)
"Managing multiple projects, objectives and deadlines", Skill Path Seminars, Ontario, CA (2005)
"International Symposium on Waterbourne Cryptosporidium, AWWA", Riverside, CA (1997).
"The Microlife, A Wastewater Biology Course, Pennsylvania State University", Irvine, CA (1996)
"Source Water Protection and Treatment Optimization" California Department of Health Services Drinking Water Field Operations Branch, San Diego District, 1996.

Publication & Television Acknowledgements:
"Fecal Indicator Bacteria Levels During Dry Weather from Southern California Reference Streams", Southern California Coastal Water Research Project, (2008)
"Destination Truth: Mongolian Devil Worm", Sci-fi Channel, (2008)

Presentations:
"How a Wastewater Treatment Plant Works", (2008)
"Frequently Asked Client Questions Concerning Coliform Bacteria", (2007)
"Bacteriological Department Drinking Water Results and their Significants", (2007)
"What is Coliform Bacteria", (2007)
Environmental Expo, California State University San Bernardino, (2007)
Technical, Environmental, Analytical Meeting (TEAM), "Methodologies utilized in the
Laboratory for Bacterial Analysis" (2005)

Awards:
Outstanding Manager of the Year – ESB & Sons, Inc. (2009)
Excellence in Quality Assurance (2008)
Certificate of Appreciation TEAM Lecture Series (2005)

Associations:
American Water Works Association

RESUME

Cathleen S. Iijima, Director of Client Services

Education:

B.A. Liberal Studies, 1985, University of California, Riverside, CA.

Professional Experience:

Ms. Iijima has over 25 years of experience in the environmental laboratory business. She is responsible for sample log-in, project management, and the general front office function. Ms. Iijima trains new office staff, coordinates with field staff to set up sampling schedules, and oversees and assists in data entry and report generation. She has been instrumental in the development and implementation of the Laboratory Information Management System (LIMS) as it pertains to the log-in and invoicing activities.

Ms. Iijima participates in the marketing function assisting staff with price quotations and marketing materials. She attends industry specific trade shows on a regular basis. Ms. Iijima is well versed in customer service. She works with a variety of clients to successfully implement their projects.

Additional Training:

"Treatment Options for Hexavalent Chromium, Perchlorate and Nitrates", Riverside, CA (2011)
"2011 Regulatory Updates for Wastewater and Drinking Water: Solving the Puzzle", Riverside, CA (2011)
"Water Sampling Guidelines & Testing for Bacteria in Water: Everything You Always Wanted to Know (but were afraid to ask!)", Riverside, CA (2010)
"EPA Drinking Water Regulatory Update", Water Quality and Regulatory Conference, Ontario, CA (2010)
"Regulatory Update", Water Quality and Regulatory Conference, Ontario, CA (2010)
"Emergency Response: Lessons Learned from the April 4th, 2010 Baja Earthquake", Riverside, CA (2010)
"Monitoring For Emerging Contaminants in Municipal Water Supplies", Riverside, CA (2010)
Webinar- "Are The Right Things Getting Done? Creating A Culture of Accountability" (2010)
"Stormwater Monitoring in Southern California – Maintaining and Preserving our Watersheds", Riverside, CA (2010)
"Recycled Water Series Part II: Working With Your Regulatory Agency to Achieve Program Success", Riverside, CA (2009)
"Recycled Water: Regulatory Reality & Public Expectations", Riverside, CA (2009)
"Golden Guardian 2008 Emergency Response Exercise – Lessons Learned by Water Industry Professionals", Riverside, CA (2009)
"California's Drought Conditions: How Will You Deal with On-Going Water Shortages?" Riverside, CA (2008)
"Endocrine Disruptors (EDCs), Pharmaceuticals & Personal Care Products (PPCPs): Actions, Communications and Prevention", Riverside, CA (2008)
"UCMR 2 – The Good, the Bad and the Ugly", Riverside, CA (2007)

Additional Training (cont.):
"Drinking Water Regulatory Update – What's Coming Down the Pipeline?" Riverside, CA (2007)
"UCMR 2 Webcast" Riverside, CA (2007)
"WaterTrax – Managing Water Data Online" Riverside, CA (2007)
"A Teamwork Approach to Environmental Laboratory Services – Panel Discussion" Riverside, CA (2006)
"2006 Regulatory Drinking Water Overview – With Special Emphasis on the IDSE and Stage 2 DBP Rule" Riverside, CA (2006)
"EPA Webcast – Overview of Two Recently Promulgated Rules: Stage 2 Disinfectants & Disinfection By Products Rule" Riverside, CA (2006)
"Water Quality Sampling Guidelines for Drinking Water and Wastewater – A Crash Course" Riverside, CA (2006)
"Stormwater Runoff in Southern California: Regulation, Compliance and Determination" Riverside, CA (2005)
"Bacteria in Drinking Water: Everything You Always Wanted To Know But Were Afraid To Ask" Riverside, CA (2005)
"Perchlorate in Southern California: Regulation, Remediation and Determination" Riverside, CA (2005)
"The Six Disciplines of Business" Estrada Strategies, CEO Teleconference, Riverside, CA (2004-2008)
LIMS Implementation, Element Datasystems (Promium) (2002)
ICR Workshop, AWWA (1996)
La Sierra University School of Business & Management - Marketing Seminar Series via University 2000 program (1994-1996)
Transportation of Hazardous Materials/Waste, Hazardous Material Safety Training (1994)
LIMS Implementation, Automated Compliance Systems (1994)

Presentations:
"Reading and Interpreting Your Laboratory Results"
California Rural Water Association – Lake Tahoe, NV (2010)

"Working Efficiently with your Laboratory"
TEAM Event, Edward S. Babcock & Sons, Inc. - Riverside, CA (2006)

Associations:
Professional Environmental Marketing Association (PEMA)

Awards:
Outstanding Manager of the Year, Edward S. Babcock & Sons, Inc. (2008)

RESUME

Cyndi K. Moore, Vice President of Sales and Marketing

Education:
MBA - University of La Verne, La Verne, CA.
B.A. Political Science - University of California, Riverside, CA.

Professional Experience:
Sales and marketing of environmental laboratory services for ESB since 1993. Current responsibilities include:

- Sales of ESB Analytical Services to new clients
- Development of Comprehensive Sales & Marketing Plan (including Research & Analysis)
- All Advertising and Promotional Activities (including all trade shows and website maintenance)
- Coordination and Preparation of All Bid Proposals and Price Quotations
- Negotiation of Contractual Agreements with Clients and Subcontract Labs
- Attendance at Industry Seminars and Meetings to Gain Knowledge of Changing Regulations and to Maintain Contact with Clients and Potential Clients
- Maintenance and Expansion of ESB Customer Base

Training:
"Treatment Options for Hexavalent Chromium, Perchlorate and Nitrates", Riverside, CA (2011)
"2011 Regulatory Updates for Wastewater and Drinking Water: Solving the Puzzle", Riverside, CA (2011)
"Water Sampling Guidelines & Testing for Bacteria in Water: Everything You Always Wanted to Know (but were afraid to ask!)", Riverside, CA (2010)
"Emergency Response: Lessons Learned from the April 4th, 2010 Baja Earthquake", Riverside, CA (2010)
"Monitoring For Emerging Contaminants in Municipal Water Supplies", Riverside, CA (2010)
"Stormwater Monitoring in Southern California – Maintaining and Preserving our Watersheds", Riverside, CA (2010)
"Recycled Water Series Part II: Working With Your Regulatory Agency to Achieve Program Success", Riverside, CA (2009)
"Recycled Water: Regulatory Reality & Public Expectations", Riverside, CA (2009)
"Golden Guardian 2008 Emergency Response Exercise – Lessons Learned by Water Industry Professionals", Riverside, CA (2009)
California's Drought Conditions: How Will You Deal with On-Going Water Shortages?" Riverside, CA (2008)
"Endocrine Disruptors (EDCs), Pharmaceuticals & Personal Care Products (PPCPs): Actions, Communications and Prevention", Riverside, CA (2008)
"UCMR 2 – The Good, the Bad and the Ugly", Riverside, CA (2007)
"Drinking Water Regulatory Update – What's Coming Down the Pipeline?" Riverside, CA (2007)
Sandler Sales Institute Courses 2005-2006 – Estrada Strategies, Ontario, CA.
"UCMR 2 Webcast" Riverside, CA (2007)
"WaterTrax – Managing Water Data Online" Riverside, CA (2007)
"A Teamwork Approach to Environmental Laboratory Services – Panel Discussion" Riverside, CA (2006)

Training (cont.)

"2006 Regulatory Drinking Water Overview – With Special Emphasis on the IDSE and Stage 2 DBP Rule" Riverside, CA (2006)
"EPA Webcast – Overview of Two Recently Promulgated Rules: Stage 2 Disinfectants & Disinfection By Products Rule" Riverside, CA (2006)
"Water Quality Sampling Guidelines for Drinking Water and Wastewater – A Crash Course" Riverside, CA (2006)
"Stormwater Runoff in Southern California: Regulation, Compliance and Determination" Riverside, CA (2005)
"Bacteria in Drinking Water: Everything You Always Wanted To Know But Were Afraid To Ask" Riverside, CA (2005)
"Perchlorate in Southern California: Regulation, Remediation and Determination" Riverside, CA (2005)
"Emergent Contaminants Technical Seminar", Irvine, CA (2005)
"Helping Municipalities Cope with Environmental Issues", Los Angeles, CA (2004)
"Your Quality Approach to Customer Service & Sales" Riverside, CA (2004)
"Perchlorate in California's Groundwater", Groundwater Resources Association, Glendale, CA (2004)
"Perchlorate and NDMA in Groundwater: Occurrence, Analysis & Treatment", Groundwater Resources Association, San Gabriel, CA (2002)
"Sustaining Groundwater Resources: The Critical Vision", Newport Beach, CA (2002)
"System Water Quality Workshop", American Water Works Association, Pomona, CA (2002)
"Southern California Arsenic Workshop", HDR Engineering, Pomona, CA (2002)
"Characterization & Remediation of Recalcitrant & Emerging Contaminants", Groundwater Resources Association, San Jose, CA (2001)
"How to Comply With the State's General Permit for Storm Water Associated with Industrial Activities", California Regional Water Quality Control Board, Santa Ana Region, Riverside, CA (2000)
"Intensive Project Management Training", Professional Environmental Marketing Association, Anaheim, CA (1996)
"Selling Environmental Laboratory Services - A Training Program", McConnaghy & Company, Denver, CO (1993)

Presentations:

"Reading and Interpreting Your Lab Results", California Rural Water Association, 2010.
"NPDES General Permit for Storm Water Discharges Associated with Industrial Activities and the Storm Water Sampling Plan", E.S. Babcock & Sons, Inc. in association with California Regional Water Quality Control Board, Santa Ana Region, 1995.

Associations:

Professional Environmental Marketing Association (PEMA)
American Water Works Association (AWWA)
California Water Environment Association (CWEA)
Inland Counties Water Association (ICWA)
Southern California Water Utilities Association (SCWUA)

Awards:

2006 Estrada Strategies Certificate of Achievement for Accomplishments in the Discipline of Growth.
2005 E.S. Babcock Most Notable Contribution Award for Client Retention and Satisfaction.

RESUME

Dr. David Feng, Senior Organics Chemist

Education:

Ph.D., Analytical Chemistry, 1987 - University of Nebraska

Professional Experience:

Dr. Feng has expertise in the GC and GC/MS analysis of a variety of environmental sample types using various specific and universal detectors and capillary columns. His analytical experience, since the year of 1982, includes Raman spectroscopy and electrochemistry. He is well versed in EPA methods utilized for the detection of volatile and semi-volatile organics, pesticides, herbicides, wet chemical methods, and EPA method requirements.

Dr. Feng has extensive experience in maintaining and trouble shooting many systems at the component level. He has also been involved in research and development and has provided project management.

Dr. Feng's current responsibilities include determination of semi-volatile organic chemicals and development of various UCMR2 methods.

Prior to joining the Babcock team in April 2002, Dr. Feng was a GC/MS analyst for Calscience Environmental Laboratories and a mobile laboratory chemist for Hydro Geo Chem, Inc. and InterPhase Environmental, Inc.

RESUME

Donna Aviles, Inorganics Manager

Education:

B.S. Chemistry, 1989, University of California, Riverside, CA

Professional Experience:

In 2008, Donna took on the position of Inorganic Manager for ESB. Her responsibilities include the overall supervision and scheduling of the workload in the Inorganic, Trace metals, and sample control departments. She will also be responsible for the data review for Inorganic and Trace Metals departments.

Ms. Aviles has been the Trace Metals supervisor since 2004. Her duties included the supervision of the staff, training and data review.

Since 1989, Ms. Aviles has been the principal chemist for trace metals determinations at Edward S. Babcock & Sons, utilizing both Inductively Coupled Plasma Spectroscopy (ICP) and Inductively Coupled Plasma Mass Spectrometry (ICP/MS) technology for groundwaters, drinking waters, wastewaters, soils and hazardous materials. She also has experience for the Mercury analysis using Hg CVAA methods. She also has extensive experience in trace metals analysis utilizing Flame Atomic Absorption (AA) and Graphite Furnace Atomic Absorption (GFAA).

In addition to trace metals analysis, Ms. Aviles is also familiar with the analysis of Chemical Oxygen Demand, Biochemical Oxygen Demand, Fluoride, Methylene Blue Activated Substances, Phenols, Alkalinity, Phosphates, Oil and Grease (HEM, SGT) and various Anions via Ion Chromatography.

During her tenure at ESB, Ms. Aviles has assisted in the formulation of new methods in addition to linearity and detection limit determinations. She is responsible for trouble-shooting analytical problems as they arise, as well as maintaining the calibration of the ICP, ICP/MS instrumentation and Hg CVAA instrumentation. Ms. Aviles is also responsible for training all metals' analysts as well as performing all peer review of data produced by the metals department. Since 2004, she has also become involved in monitoring sample control.

Prior to her employment with ESB, Ms. Aviles was a laboratory assistant at the University of California, Riverside for four years, assisting in data collection, plant propagation, plant nutritional information, greenhouse inoculation, and sterile media preparations.

RESUME

Enrique Aguilar, Inorganic Supervisor

Education:

1999-2002 California State San Bernardino San Bernardino, CA
B.A., Chemistry
1996–1999 Imperial Valley College Imperial, CA
A.S., General Science.

Professional Experience:

Mr. Aguilar is currently the Supervisor for the Inorganic department. He serves as a resource for all analyses performed within the department by answering questions regarding procedures, difficult matrices and validity of data. Mr. Aguilar also serves as a liaison between analysts, peer reviewer, QC department and supervisors in order to clarify requirements and ensure that quality data is produced.

Mr. Aguilar began working for E.S. Babcock & Sons on March 17, 2003. His is proficient performing the following analyses: Cyanide in drinking water, Fluoride, Phenols, UV254, Determination of Inorganic Anions by Ion Chromatography, Determination of CLO4 by methods 314.0 & 332.0, Volatile Acids, Biochemical oxygen demand, Alkalinity, and Physicals. He also conducts the following soil analyses: Corrositivity, Organic mater composition, and various WEX preparation procedures.

Instrumentation:

He has experience using IC, ICMS/MS, GC, GCMS, Mass Spec., NMR, IR, UV vis, and HPLC.

Other Skills:

He has extensive knowledge of the Element LIMS program. He is familiar with Widows 98, ME, XP and Microsoft Office software. He has also used Kalidagraph, and various molecular modeling programs. He has management experience and is a dedicated and loyal employee.

Training:

Creative Leadership Workshop (2008)
Supervisor Anti-Harassment Workshop (2008)
Franklin Covey- Time management Workshop (2009)
B.O.D. Focus Group (2009)
Solids Focus Group (2009)
Employers Group Lean Institute Workshop (2009)

RESUME

Fred J. Kent, Organics Manager

Education:

A.A. Chemistry, Scottsdale Community College, Scottsdale, AZ
Chemistry, Arizona State University, Tempe, AZ

Professional Experience:

Mr. Kent has been working for E.S. Babcock & Sons since 2008. His experience in the chemical analysis of waters and wastewaters includes expertise in the GC, GC/MS analysis of environmental samples.

Mr. Kent has extensive experience in maintaining and troubleshooting analytical instruments and has also been involved in project management, technical data review and the preparation of various reports.

His current responsibilities include the supervision of the analysis of water and wastewater for GC/MS Volatiles and Semi-Volatiles.

Prior to joining the Babcock team, Mr. Kent worked for Severn Trent Laboratories in Santa Ana where he was an Organics Manager for 10 years. His experience in the GC/MS Volatiles, Semi-Volatiles and Sample Extraction Departments make him an exceptional manager in our organization.

RESUME

Hsin-Yi Lee, Project Manager

Education:
B.A. Biology, 1998– California State University, San Bernardino, California

Professional Experience:
Ms. Lee has been working with E.S. Babcock & Sons, Inc. since November 2007. In her current roll as project manager, her responsibilities include setting up Project Specific Requirements within the laboratory and specifying the QA/QC needs of each project. She also is responsible for reviewing data, delivering data to the client on time, resolving problems between the laboratory and clients, providing clarification on various issues, and meeting various client requests for information. Her current clients include: The Cities of Corona, Ontario, San Bernardino, Chino Hills and Colton. Water Districts that she supports include: Western Municipal, Elsinore Valley and Metropolitan Water District. Ms. Lee was also instrumental in the oversight of a large drinking water lead project for the L.A. Unified School District that ESB participated in 2008 and 2009.

She also specialize client data deliverables and various forms of EDDs included EDT, WaterTrax, City of Corona Ops, Geotracker, and, SWAMP EDD.

Prior to working at E.S. Babcock & Sons Ms. Lee had over seven years of experience in environmental laboratories. At APCL she was responsible for interfacing with laboratory managers and supervisors on specific client requirements, due dates, and QA/QC. She worked to define project requirements and provided timely response to customer inquiries. She managed multiple projects simultaneously and worked with accounting and laboratory operations to resolve any contractual or technical issues.

Most of the projects Ms. Lee managed at that time were under the jurisdiction of the Department of Defense, which includes Navy RAC, Navy CLEAN, Army Corps TERC and other programs. She has supported Prime Contractors such as Shaw E&I, Earth Tech and CDM in successfully executing their Federal contract requirements.

She is familiar with the associated Quality Assurance programs of these programs that included the Quality Control Manual of DoD, the Quality System Manual Final Version 3, and the Navy Installation Restoration Chemical Data Quality Manual (IR CDQM). In addition, she is also familiar with the Requirements for the Preparation of Sampling and Analysis Plans, and with the Unified Federal Program Quality Assurance Project Plan.

Training:
Technical Environmental Analytical Meeting (TEAM) Events
- January 2009 Emergency Response Seminar
- October 2009 Recycled Water Series Part II
- February 2010 Stormwater Monitoring in Southern California

March 2010 Monitoring for Emerging Contaminants in Municipal Water Supplies
March 2011 Treatment Options for Hexavalent Chromium, Perchlorate and Nitrates

Furthering Our Contributions Understanding & Success (FOCUS) Training Sessions
"IC Focus Group" (May 2009)
"Pesticides & Herbicides" (September 2009)

Awards:
Excellence in Quality Assurance, Edward S. Babcock & Sons, Inc. (2009)

RESUME

James Schaupp, Senior Organic Chemist

Education:

B.S. Chemistry, 1986, University of California, Riverside, CA

Professional Experience:

Mr. Schaupp has over 20 years of experience performing organic determinations utilizing Gas Chromatography/Mass Spectroscopy. He has extensive knowledge of EPA method requirements outlined in SW-846 (for EPA Method 8141 & 8270), Methods for the Determination of Organic Compounds in Drinking Water (EPA Methods 507, 525 & 548.1), and the NPDES program (EPA Method 625). Mr. Schaupp has worked extensively with various GC detectors such as ECD, NPD, PID and FID to determine compounds such as organochlorine and organophosphorus pesticides, herbicides, and hydrocarbons. Mr. Schaupp is currently performing volatile organic analysis such as 524, 524TCP, 624, & 8260 by GC/MS(using Agilent and Varian instrumentation) and zero-headspace preparation for TCLP/VOA analysis. He has recently developed a modified volatile method to analyze for 1,4-Dioxane by isotope dilution on the Varian-GC/Saturn ion trap instrument in water and solid matrices.

Mr. Schaupp is also versed in inorganic determinations, having worked in atomic absorption spectrophotometry for mercury compounds via the cold-vapor technique, and selenium compounds via hydride generation. He has also performed TOC and UV254 analysis.

Mr. Schaupp has been instrumental in the development of the internal computing systems at Babcock and is completely familiar with HP-UX, MS-DOS, Pascal, SCO-UNIX and Windows (95/98/NT/XP/Vista).

Associations:

American Chemical Society

RESUME

Julia Diane Sudds, QA Auditor

Education:

BA in Psychology, 2000-CSUSB
BA in Human Development, 2000-CSUSB.

Professional Experience:

Mrs. Sudds has been employed at Edward S. Babcock & Sons since 1994. She has extensive experience performing inorganic determinations specializing in all inorganic wet chemistry analyses.

Mrs. Sudds was previously the assistant supervisor for the inorganic department and responsible for overseeing operations and training within the department. She served as a resource for all analyses performed within the department by answering questions regarding procedures, difficult matrices and validity of data.

From October 2007- December 2008, Mrs. Sudds had the role of Employee Development and Technical training coordinator and was responsible for coordinating and implementing the laboratories' Employee Development program as well as ongoing and new hire orientation, training and documentation.

In January 2009, Mrs. Sudds took over and currently holds the position of QA Auditor. She participates in a lab-wide internal audit program, which examines each analysis to ensure that it is method compliant. She observes and evaluates each analyst to improve his or her technique, knowledge of the method, and ensures the traceability of standards and reagents. Mrs. Sudds also assists in maintaining Standard Operating Procedures and updates them accordingly. Mrs. Sudds tracks and maintains the laboratory's training documentation history and ensures that they are updated and orderly. Training documentation includes Demonstration of Capabilities, Cell Change History, Training logs, MDL studies, etc. She also supports the QA Manager and Asst. QA Manager in any tasks as needed and serves as a liaison between analysts, peer reviewers, QC department and supervisors in order to clarify requirements and ensure that quality data is produced.

Training:

-NELAC9 Workshop on Establishing an Effective Data Integrity Plan, San Diego, CA (2003)
-TNI/NELAC Conference, Miami Fl (2009)
-TNI Workshop on Data Handling Techniques, Miami Fl (2009)
-TNI/NELAC Conference, Chicago, IL (January 2010)
-TNI Workshop "The New TNI Laboratory Accreditation Standards" Chicago, IL Jan 2010
TNI Workshop "The New TNI Laboratory Accreditation Standards" Riverside Ca, July 9 2010

RESUME

Justin Troup, Project Manager

Education:

Cal Poly Pomona — Pomona, Ca
- B.S., Chemistry

Professional Experience:

Mr. Troup began at E.S. Babcock & Sons in February of 2010. His current responsibilities as Project Manager include Data Review and Client Services.

Mr. Troup's previous work experience includes six years of experience as an environmental chemist in the arenas of water and air quality. His tenures include time at Test America as an interim microbiology supervisor and an extractions chemist. He has also work for the Metropolitan Water District of Southern California where his primary responsibilities were assisting in the method development for the determination of pharmaceuticals & personal care products (PPCP's) also known as constituents of emerging concern (CEC's). Justin's graduate research focuses on examining the inhibition of the fusion peptide of HIV-1.

Instrument and Technical Proficiencies

LC & LC-MS

Training

Technical Environmental Analytical Meeting (TEAM) Events

- March 2010 Monitoring for Emerging Contaminants in Municipal Water Supplies
- June 2010 - Emergency Response: Lessons Learned from the April 4th, 2010 Baja California Earthquake
- September 2010 - Water Quality Sampling Guidelines & Testing for Bacteria in Water: Everything You Always Wanted to Know (but were afraid to ask!)
- March 2011 - Treatment Options for Hexavalent Chromium, Perchlorate & Nitrates

RESUME

Lawrence James Chrystal, Laboratory Technical Director

Education:
B.S. Biology, 1975, University of California, Riverside, CA.

Professional Experience:
Mr. Chrystal has worked in the environmental testing field since 1975. He is the technical director for both the Microbiological and Chemical laboratories. He has extensive experience in trace organic and inorganic analyses, specializing in GC/MS, LC-IC/MS/MS, GC, HPLC, Ion Chromatography, atomic absorption, spectral emission, and ICP/MS techniques. Mr. Chrystal has directed work done under contract for the U.S. Environmental Protection Agency and the State of California as well as many municipalities and private firms. The scope of work encompasses analysis of soil, water, wastewater, air and chemical wastes. He is responsible for method development, data validation, quality control and the overall operation of the laboratory including analytical methodology, client relations, budgeting, employee performance, and knowledge of environmental legislation and regulatory requirements. Mr. Chrystal has served on the faculty at the University of California, Riverside extension program teaching a course entitled "Analytical Chemistry for the Characterization of Hazardous Materials".

Presentations:
"Current Laboratory Techniques for the Determination of CECs", CWEA Annual Conference Ontario, CA April 2011.

"Determination of Perchlorate: Suppressed Conductivity vs Mass Spectrometry"
EVWD 2004 Water Quality Conference – Ontario, CA 2004

"Proper Collection and Preservation Techniques for Drinking Water"
City of Ontario Water Department – Ontario, CA 2004

"*Sampling and Analysis of Environmental Samples for Compliance and Investigation*" – Regional Water Quality Control Boards 7&8 – Riverside, CA 2003

"Analytical Chemistry for the Characterization of Hazardous Materials" – California Department of Toxic Substances Control (DTSC) – Cypress, CA and Berkeley, CA, 2000

"*Using ICP-MS for the Determination of Trace Metals in Waters, Wastewaters and Sludges*" – CWEA 1997 SRTC Laboratory Program – Irvine, CA and Laughlin, NV 1997, 1999

"*Analytical Determinations of Petroleum-Based Products*" County of Riverside Department of Environmental Health -- Riverside, CA, 1996.

"*Laboratory Practices - Parts I & II*" -- California Regional Water Quality Control Board, Santa Ana Region - Riverside, CA, 1995.

"*A Novel Solid Phase Extraction Method for the Isolation and Quantitation of Chlorophenoxy Herbicides from Environmental Matrices*" FACSS/Pacific Conference -- Anaheim, CA, 1991

"*The Role of the Analytical Laboratory in the Removal of Underground Storage Tanks*" - University of California, Riverside, Extension -- Riverside, CA, 1991.

"*Proper Sampling and Preservation Procedures for Environmental Matrices*" - Rancho Santiago College (JIC) - Santa Ana, CA, 1990.

"*Purge and Trap Techniques in the Gas Chromatographic Analysis of Environmental Samples*" - Rancho Santiago College (JIC) - Santa Ana, CA, 1988.

Associations:
American Chemical Society (ACS)
California Water Environment Association (CWEA)
Association of Official Analytical Chemists (AOAC)
Society of Applied Spectroscopy (SAS)

RESUME

Lorenzo Rodriguez, Project Manager

Education:

Degrees:

California State University, San Bernardino CA **June 2001**

- Bachelors of Arts in Chemistry - Biochemistry

Riverside Community College, CA **June 2009**

- A.A. in Computer Programming

Certificates:

Riverside Community College **January 2009**

- CIS – Systems Development
- CIS – Computer Programming
- CIS – C++ Programming
- CIS – Java Programming
- CIS - CISCO Networking

Professional Experience:

Mr. Rodriguez has been working with E.S. Babcock & Sons, Inc. since June 2004. In his current role as project manager, his responsibilities include setting up project specific requirements within the laboratory and specifying the QA/QC needs of each project. He also is responsible for reviewing data, delivering data to the client on time, resolving problems between the laboratory and clients, providing clarification on various issues, and meeting various client requests for information. His current and past clients include: Veolia Water, Victor Valley Wastewater Reclamation Authority, Regional Water Quality Control Board-Santa Ana Region, Regional Water Control Board – Lahontan Region, San Bernardino County Department of Public Works – Flood Control, Tetra Tech – San Bernardino, and the Department of Toxic Substance Control.

Prior Experience includes: As a Mobile Lab Chemist/GCMS Analyst, performed a variety of analyses by EPA methods 8260 and 524.2. Performed primary and secondary date review for field and final reports. Updated and maintained SOPs, logbooks, and mobile lab documentation. Communicated directly with clients in the field in a professional and customer service oriented manner to meet their environmental analysis needs.

Training:

Technical Environmental Analytical Meeting (TEAM) Events

- October 2007 - UCMR2 Seminar
- January 2009 - Emergency Response Seminar
- October 2009 Recycled Water Series Part II

- January 2010 - Stormwater Monitoring in Southern California - Maintaining & Preserving our Watershed
- March 2010 Monitoring for Emerging Contaminants in Municipal Water Supplies
- June 2010 - Emergency Response: Lessons Learned from the April 4th, 2010 Baja California Earthquake
- September 2010 - Water Quality Sampling Guidelines & Testing for Bacteria in Water: Everything You Always Wanted to Know (but were afraid to ask!)
- January 2011 - 2011 Regulatory Updates for Wastewater and Drinking Water: Solving the Puzzle
- March 2011 - Treatment Options for Hexavalent Chromium, Perchlorate & Nitrates
- April 2011 – BIO-14 Soil Science Management, Riverside Community College

Instrumentation and Technical Proficiencies:

Instruments

- GC and GC/MS

Software

- Electronic Deliverables: Write-On EDTs, GeoTracker, SWAMP, CIQWS, ADRs, and various client specific EDDs
- EnviroQuant (Data Quantitative Program)
- Element (Laboratory Information Management System)
- Goldmine (CRM)

RESUME

LuAnn Thomas, Senior Inorganic Chemist

Education:

A.A. General Education, 1984 - Riverside Community College, Riverside, CA

Professional Experience:

With analytical lab experience since 1990, Ms. Thomas is currently a Senior Chemist in the Metals department. She is currently operating the Optima 5300 DV and is responsible for trace metals analysis. Ms. Thomas performs hazardous materials prep digestion and sample analysis. She also analyzes TOC solid and sludges using a Shimadzu SSM 5000-A solid sample module.

Ms. Thomas' instrumentation experience includes: Graphite Furnace Atomic Absorption, Flame Atomic Absorption, Inductively Coupled Plasma Spectroscopy, Inductively Coupled Plasma Mass Spectrometry, Ion Chromatography, and Flow-Through Spectrophotometry. She is completely familiar with sample preparation, dilutions, titrations, quality control, data collection, and data review. LuAnn duties also include final review of Inorganic reports.

Ms. Thomas has also performed the following analyses: Total Hardness, Calcium, Magnesium, Sodium, Sulfate, Chloride, Anions, BOD, COD, Cyanide, Oil and Grease, MBAS (Surfactants), Phenols, Sulfide, Ortho-Phosphorus, Total Phosphorus, pH, Specific Conductance, Total Filterable Residues and Total Suspended Residues.

Training:

Perkin-Elmer Technical Training Center - "Training Program in Atomic Spectroscopy for the Inductively Coupled Plasma W/GEM 3100/4100/5100" May, 1995.

Awards:

YWCA - Women of Achievement Certificate - 1994

RESUME

Marianna Etcheverria, Controller

Education:

MBA, 1993 University of LaVerne, LaVerne, CA
BS in Economics, 1986 California State Polytechnic University, Pomona

Professional Experience:

Ms. Etcheverria has over 24 years of experience in financial control and accounting. In her current role at Babcock Laboratories, she is overseer of the accounting department function that includes Accounts Receivable, Accounts Payable, Purchasing and Payroll.

Ms. Etcheverria prepares and analyzes the Annual Budget for Operations, Income Statements, Balance Sheets, month-end and quarterly reports, for the principals of the corporation to review and to aid in their decision-making process.

Ms. Etcheverria is a member of the Strategic Planning committee

Prior to joining the Babcock team, Ms. Etcheverria worked for the Valle Lindo School District where she was the Assistant Superintendent of Business for 10 years. Her extensive experience in financial accounting, analysis and reporting has prepared her for her current duties.

Professional Accomplishments:

Implemented and/or updated the accounting system for Accounts Payable, Accounts Receivable, Payroll and Purchasing for a more efficient operation.

Implemented an Annual Budget to provide financial control for the business operation.

Successfully implemented and refined policies and procedures to reflect Generally Accepted Accounting Principles (GAAP).

Researched and recommended budgetary cost reductions while maintaining operational effectiveness.

RESUME

Mark F. Tracy, Field Operations Manager

Professional Experience:

Mr. Tracy has worked in the environmental sampling field since 1980. He has extensive technical experience in all aspects of field operational services and is conversant with a variety of sampling techniques. Mr. Tracy is an expert in time and flow composite sampling of industrial and municipal discharges permitted under the NPDES program as described in 40 CFR 136. Mr. Tracy has directed fieldwork done under contract for the State of California as well as many municipalities and private firms for soil, water, wastewater and hazardous wastes, including field sampling, preservation, chain of custody and 24-hour composite sampling techniques. He is responsible for the overall operation of the field department including customer service, scheduling of routine and non-routine sampling events, time management, field employee performance, and knowledge of environmental legislation and regulatory requirements as they relate to sampling techniques. His experience in groundwater sampling and analysis entails protocol which complies with the requirements of Article 5, Chapter 15, Title 23, of the California Code of Regulations and 40 CFR 258 for sanitary landfill monitoring wells.

Education and Training:

Tri-State Seminar-On-The-River – Miscellaneous classes related to safety and sampling issues, September, 2003.

Hazwoper Training (Hazardous Waste Operations & Emergency Response), Safety Dynamics Group, July, 2003.

Water Distribution Operator, Grade 3, Operator Number 5122, State of California, Department of Health Services (in accordance with Division 104, Part 1, Chapter 4, Article 3 of the Health and Safety Code), April 2001.

Safety Seminar for Water/Wastewater Training, SARBS Southern Regional Section March, 1994.

AWWA Confined Space Entry Seminar, February, 1994

Certificate in Water Supply and Reclamation Engineering Technology, San Bernardino Valley College, June, 1992.

Water Distribution Operator, Grade 2, Certificate Number 5122, American Water Works Association, California-Nevada Section, February, 1992.

Water Treatment Operator, Grade 2, Operator Number 16553, State of California, Department of Health Services (in accordance with Chapter 9, Division 5 of The Health and Safety Code), November, 1991.

AWWA Water Sampling Seminar, February 1991.

Presentations:
"Water Quality Sampling Guidelines For Drinking Water and Wastewater – A Crash Course", ESB TEAM Event, January 26, 2006.

Associations:
California Water Environment Association (CWEA)
Institute for National Environmental Laboratory Accreditation (INELA)

RESUME

Robin R. Glenney, Project Manager

Education:

1999-2006 California State University Long Beach
Bachelors of Science in Marine Biology
Bachelors of Science in Biology option Zoology

Professional Experience:

Ms. Glenney has been working with Babcock Laboratories since 2007. She initially worked as a sample receiving assistant in our login department. Her duties were to receive samples, check for proper sample acceptability, log bacteriological and chemical analyses for the samples received into the LIMS system, replenish client supplies and distribute samples to their appropriate departments.

In current roll as project manager, her responsibilities include setting up project specific requirements, reviewing data, delivering data to the clients on time, meeting client requests for information, coordinating with field staff to set up sampling schedules and supplying clients with price quotations and marketing materials.

Prior to working at Babcock Laboratories Ms. Glenney has had over thirteen years of customer service experience. Throughout her previous experience Ms. Glenney was responsible for coordinating and implementing various programs, as well as interfacing with managers and supervisors on specific client requests, scheduling dates, and program requirements.

Training:

Water Quality/Infrastructure WS, AWWA, December 2008

Technical Environmental Analytical Meeting (TEAM) Events
October 2007 - UCMR2 Seminar
January 2009 - Emergency Response Seminar
January 2010 - Stormwater Monitoring in Southern California - Maintaining & Preserving our Watershed
June 2010 - Emergency Response: Lessons Learned from the April 4th, 2010 Baja California Earthquake
September 2010 - Water Quality Sampling Guidelines & Testing for Bacteria in Water: Everything You Always Wanted to Know (but were afraid to ask!)

January 2011 - 2011 Regulatory Updates for Wastewater and Drinking Water: Solving the Puzzle
March 2011 - Treatment Options for Hexavalent Chromium, Perchlorate & Nitrates

Furthering Our Contributions Understanding & Success (FOCUS) Training Sessions
April 2009 - Solids
May 2009 - Ion Chromatography
May 2010 - Metals
September 2010 - Chromatography

Professional Accomplishments:

Nominated for 2008, 2009 and 2010 Sherm Award Outstanding Employee of the Year

RESUME

Stacey A. Fry, Quality Assurance Manager

Education:
B.S. Biological Sciences- University of California, Riverside, CA

Professional Experience:
In 2008 Ms. Fry took on the position of Quality Assurance Manager for ESB. Her duties include overseeing the Quality Assurance program, maintaining NELAP and ELAP certification, and performing Ethics training for the laboratory.

For 12 years Ms. Fry was responsible for the overall supervision and work scheduling of the Inorganics, Organics, Metals and Sample Control Departments. This included reviewing all data produced by each department.

Ms. Fry has been employed at Edward S. Babcock & Sons since 1995. She has extensive experience performing inorganic determinations specializing in all inorganic wet chemistry analyses. These include Alkalinity, Ammonia, Anions, Trace Metals, COD, BOD, TDS, TSS and Sulfide. She is well versed in the Standard Methods and EPA Methods utilized for these analyses. She is knowledgeable in Inductively Coupled Plasma Spectroscopy and Lachat/FIA. In addition, Ms. Fry has extensive experience with Ion Chromatography (including troubleshooting and maintenance of the instrumentation) and is very familiar with the analysis of Perchlorate, Oxyhalides and Bromide. She has attended numerous training seminars covering both Ion Chromatography and Perchlorate and has also worked directly with the Lab Director to develop the Perchlorate methods used by the laboratory. She has also worked extensively in sample preparation, dilutions, titrations, quality control, and data collection.

Prior to her employment with Edward S. Babcock & Sons, Inc., Ms. Fry worked for the Electro Pneumatic Corporation in Riverside, CA for 7 years as an electronic and quality control technician.

Training:
Mini-Vidas training, Riverside, CA, 4/16/2011
Basic Food Safety Microbiology, Las Vegas, NV, 4/04/2011
"The New TNI Laboratory Accreditation Standards" Riverside, Ca July 9, 2010
CWEA Training Class- "Technical Writing", Orange County, March 11, 2010
Webinar- "Are The Right Things Getting Done? Creating A Culture Of Accountability" (March 2010)
TNI/NELAC Conference, Chicago, IL (January 2010)
TNI Workshop "The New TNI Laboratory Accreditation Standards" Chicago, IL Jan 2010
TNI/NEMC Conference, San Antonio TX, August 2009
TNI Workshop "How to Use Qualified Data" San Antonio TX 2009

TNI Workshop "Testing Requirements of EPA Regulations" San Antonio TX 2009
TNI Workshop "Data Handling Techniques" Miami FL (2009)
TNI/NELAC Conference, Miami FL (2009)
"UCMR 2" Webcast, Riverside CA (2007)
"UCMR 2- The Good, the Bad and the Ugly", Riverside CA (2007)
"WaterTrax-Managing Water Data Online" Riverside, CA (2007)
NELAC Data Review and Validation, Chicago IL (2007)
TEAM "Methodologies utilized in the Laboratory for Bacterial Analysis", ESB & Sons, Inc. (2005)
NELAC 11*i* Workshop on "Data Review for Conformance to the NELAC Standard", August, 2005
Perchlorate Regulation in California, ESB & Sons, Inc (2005)
NELAC9 Workshop on "Establishing an Effective Data Integrity Plan", San Diego CA (2003)
NELAC10 Workshop, Charleston South Carolina (2004)
LIMS Implementation, Element Datasystems (Promium) (2002)

Awards:
Outstanding Manager of the Year, ESB & Sons, Inc (2007)

Presentations:
FOCUS (Furthering Our Contributions, Understanding & Success) - BOD Focus Group (March 2009)
FOCUS- Solids (April 2009)
FOCUS- Ion Chromatography (May 2009)

Associations:
Institute for National Environmental Laboratory Accreditation (INELA)
American Chemical Society (ACS)
TNI PT Board Sub-committee member, January 2009-present
TNI Quality Manual Template committee member, 2010

RESUME

Susann K. Thomas, Laboratory Director of Operations

Education:

B.S Biological Sciences, 1987 - California Polytechnic University Pomona, CA.

Professional Experience:

Ms. Thomas has been employed with Edward S. Babcock & Sons since 1988. She has expertise in environmental analytical chemistry specializing in the areas of trace metals, wet chemistry, chromatography, quality assurance, and employee management.

Currently Ms. Thomas is serving as Laboratory Director of Operations, a position she has held since April of 2011.

As Laboratory Director of Operations, Ms Thomas is responsible for the day to day operation of the laboratory. She is responsible for developing and implementing protocols for all laboratory functions and ensuring that testing performed in the laboratory conforms to recognized standards of accuracy and quality assurance.

Responsibilities of the Laboratory Director include; the review of methods, testing, quality control and other operational reports to ensure that quality standards, regulatory requirements, efficiencies, and schedules are met. The Laboratory Director monitors contractual obligations and workload in conjunction with instrumentation and staffing to ensure adequate laboratory capacity. She is also responsible for maintaining all permits and certifications. She is responsible for Laboratory staff development. Ms Thomas develops performance measures for evaluating the profitability of the laboratory operations, including budgeting and capital equipment needs and making recommendations regarding the pricing for laboratory and testing services.

Previously Ms Thomas served as Assistant QA Manager for 13 years. During that time she ran a lab-wide audit program which examined each analysis for method compliance. She is knowledgeable in all EPA and Standard Methods used in the laboratory. She authored and updated all Standard Operating Procedures for the laboratory. She assisted the QA Manager in all areas of Quality Assurance including acting as Interim QA Manager April 2005- July 2005 and March 2008 – September 2008. Ms Thomas has been a key facilitator during NELAP On site Assessments and is well versed in all aspects of the standard.

Prior to Assistant QA Manager, Ms Thomas served as the Inorganic Supervisor for 8 years During that time she coordinated the work load of that department, ensured quality of results, reviewed reports, and supervised employees.

Initially Ms Thomas worked for 2 years as a bench chemist in the Inorganics and Organics Department performing several wet analyses as well as Ion Chromatography, Gas Chromatography, and HPLC.

Training:
Laboratory Analyst Grade 3 Certificate #201, California Water Environment Association (1993)

Hazardous Materials Management Certificate, University of California, Riverside, CA (1992)

NELAC9 Workshop on Establishing an Effective Data Integrity Plan, San Diego, CA (2003)

The NELAP Institute, The Forum on Laboratory Accreditation, Newport Beach, CA (2008)

The NELAP Institute, The New TNI Laboratory Accreditation Standards, Riverside, CA (2010)

Presentations: (author and presenter)
"A First Responder's Guide to Sampling Hazardous Materials" December 2010 Riverside County Hazmat Operations Group, Riverside

"Water Quality Sampling Guidelines – How to Obtain a Sample Which Retains Its Scientific Integrity and is Legally Defensible" September 2010 Technical, Environmental, Analytical Meeting, Riverside

"Ethics and Data Integrity in the Laboratory" November 2009 Mt. San Jacinto College, Environmental Laws and Regulations.

"Reading and Understanding Laboratory Reports" November 2009 Regional Water Quality Control Board, Lahontan Victorville

"Water and Wastewater Chemist" May 2008 thru Jan 2011 – Ongoing, various youth organizations.

"Proper Sample Containers and Preservation". November 2008, Regional Water Quality Control Board #8 Santa Ana

"Unregulated Contaminant Monitoring Regulation 2 Sampling and Quality Control Requirements", November 11, 2008, Technical, Environmental, Analytical Meeting, Riverside

"Troubleshooting Techniques for the Analysis of N-Methylcarbamoyloximes, N-Methylcarbamates, and Glyphosate When Using HPLC with Post-Column Derivatization and Fluorescence Detection", October 1991, CWEA Conference.

Associations and Awards:
California Water Environment Association (CWEA)

20 years of service pin, Edward S. Babcock & Sons 2008

Edward S. Babcock and Sons Notable Contribution Award 2006

"Lab Person of the Year" 1993, Santa Ana River Basin section of the California Water Environment Association.

RESUME

William R. Bayle, Senior Field Technician

Education:

High School Graduate, 1975 - Arlington High School, Riverside, CA

Professional Experience:

Since 1988 Mr. Bayle has worked at E.S. Babcock & Sons, Inc. His primary duties include sampling groundwater, wastewater (grabs and 24 hour composites) and drinking water.

In addition to sampling, Mr. Bayle is an expert in 24-hour flow weighted monitoring.

Mr. Bayle has extensive training in the proper collection, labeling, custody maintenance, handling, storage, and transportation of drinking water, wastewater, soils and hazardous materials. He also performs various analytical tests in the field such as chlorine residual, pH and temperature.

Mr. Bayle is a very conscientious employee who is dedicated to providing our clients with the highest level of service.

Training:

Grade 1 Waste Distribution Operator - American Water Works Association May 2005

Hazardous Waste Sampling Class (ESB)

UCR Extension - Well Drilling Seminar

Appendix E Job Descriptions of Key Personnel

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Project Manager
Department: Administration
Reports To: Director of Client Services
FLSA Status: nonexempt

SUMMARY
Acts as liaison between client services, marketing and the laboratory to provide analytical testing services in compliance with client requirements and produce final project deliverables.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Reviews and is familiar with all contract and project specific requirements such as turn around times, methods, analyte lists and reporting limits.

Is an Edward S. Babcock & Sons, Inc. approved signatory.

Through communication with sample receiving and the laboratory, ensures that all testing and reporting is performed to meet these requirements.

Reviews and verifies data deliverables, including quality control reports, for final reporting to clients. Whenever possible, uses knowledge of project and/or client to verify consistency of analytical data. Compares data with historical trends, when available.

Tracks and prepares special client specific quality control reports and other project specific required reports.

Verifies proper contract invoicing.

Assists the Quality Assurance Department when needed.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) from four-year college or university and 3 years environmental laboratory experience; or minimum of 7 years environmental laboratory experience and/or

training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret scientific periodicals, professional journals, technical procedures, or governmental regulations. Ability to write reports, business correspondence, and procedure manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and the general public.

MATHEMATICAL SKILLS
Ability to work with mathematical concepts such as probabilities and statistics Ability to apply concepts such as fractions, percentages, ratios, and proportions in laboratory calculations.

REASONING ABILITY
Ability to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Ability to interpret a variety of instructions furnished in written, oral, diagram, or schedule form.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; use hands to manipulate instrumentation and computers; reach with hands and arms; and talk or hear. The employee is occasionally required to walk, sit, and detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Prepared Date: October 15, 2002

E. S. Babcock & Sons, Inc.
Job Description

Job Title:	Microbiology Laboratory Manager
Department:	Microbiology Department
Reports To:	Laboratory Technical Director
FLSA Status:	exempt

SUMMARY
Plans and directs activities of the Microbiology Dept. by performing the following duties personally or through subordinate employees.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Reviews test data, quality control, and other laboratory information generated by the Microbiology Dept. Monitors sample holding times and incubation times to ensure all regulatory and client project requirements are met.

Ensures all Quality Assurance/Quality Control practices and procedures are followed by laboratory personnel.

Identifies and addresses problems with staffing and equipment.

Enforces safety policies and ensures employee adherance to company policies and practices including, but not limited to, issues of client confidentiality and ethical and legal behavior.

Notifies clients and regulators promptly when bacteriological results are positive. Interprets department results to clients, laboratory personnel, management, and professional and technical societies.

Oversees the maintenance and upkeep of all department instrumentation.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES
Directly supervises three to four laboratory technicians in the Microbiology Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include interviewing, hiring, and training employees; planning, assigning, and directing work; appraising performance; rewarding and disciplining employees; addressing complaints and resolving problems.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) in Microbiology or related field from four-year college or university and minimum 3 years environmental laboratory experience; or minimum of seven years related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret common scientific and technical journals. Ability to respond to common inquiries or complaints from customers and regulatory agencies. Ability to write speeches and articles for publication that conform to prescribed style and format. Ability to effectively present information to top management, public groups, and/or boards of directors.

MATHEMATICAL SKILLS
Ability to apply advanced mathematical concepts such as exponents, logarithms, quadratic equations, and permutations. Ability to apply mathematical operations to such tasks as frequency distribution, determination of test reliability and validity, analysis of variance, correlation techniques, sampling theory, and factor analysis.

REASONING ABILITY
Ability to define problems, collect data, establish facts, and draw valid conclusions. Ability to interpret an extensive variety of technical instructions in mathematical or diagram form and deal with several abstract and concrete variables.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to talk or hear. The employee frequently is required to stand; sit; and use hands to manipulate a computer keyboard and delicate instrumentation. The employee is frequently required to reach with hands and arms and ocassionally required to detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: November 3, 1999

E. S. Babcock & Sons, Inc.
Job Description

Job Title:	Inorganic Department Manager
Department:	Chemistry Department
Reports To:	Laboratory Director
FLSA Status:	exempt

SUMMARY
Plans and directs activities of the Inorganic Department by performing the following duties personally or through subordinate employees.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Reviews test data, quality control, and other laboratory information generated by the Inorganic Department.

Monitors sample progress, holding times and turn around times to ensure all regulatory and client project requirements are met.

Ensures all Quality Assurance/Quality Control practices and procedures are followed by laboratory personnel.

Identifies and addresses problems with staffing and instrumentation.

Enforces safety policies and ensures employee adherence to company policies and practices including, but not limited to, issues of client confidentiality and ethical and legal behavior.

Interprets results of laboratory activities to clients, laboratory personnel, management, and professional and technical societies.

Oversees the maintenance and upkeep of all department instrumentation.

Possesses the ability to structure workday to effectively interact with subordinates and co-workers to sufficiently perform all assigned job duties and other miscellaneous tasks.

Possesses the ability to effectively lead and manage others while gaining cooperation of subordinates, co-workers, supervisors and upper management.

Follows direction from supervisor and shows commitment to meeting deadlines.

Has ability to give and receive constructive criticism and communicates well with others.

Contributes positively to company morale.

Identifies problems and uses appropriate resources to find solutions.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES
Directly supervises two supervisors and 20 subordinates in the Chemistry Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include interviewing, hiring, and training employees; planning, assigning, and directing work; appraising performance; rewarding and disciplining employees; addressing complaints and resolving problems.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) in Chemistry or related field from four-year college or university and minimum 5 years environmental laboratory experience; or minimum of eleven years related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret common scientific and technical journals. Ability to respond to common inquiries or complaints from customers and regulatory agencies. Ability to write speeches and articles for publication that conform to prescribed style and format. Ability to effectively present information to top management, public groups, and/or boards of directors.

MATHEMATICAL SKILLS
Ability to apply advanced mathematical concepts such as exponents, logarithms, quadratic equations, and permutations. Ability to apply mathematical operations to such tasks as frequency distribution, determination of test reliability and validity, analysis of variance, correlation techniques, sampling theory, and factor analysis.

REASONING ABILITY
Ability to define problems, collect data, establish facts, and draw valid conclusions. Ability to interpret an extensive variety of technical instructions in mathematical or diagram form and deal with several abstract and concrete variables.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to talk or hear. The employee frequently is required to stand; sit; and use hands to manipulate a computer keyboard and delicate instrumentation. The employee is occasionally required to reach with hands and arms and detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Angela Cossey
Date of Revision: August 26, 2008 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title:	Field Operations Manager
Department:	Field Department
Reports To:	Laboratory Technical Director
FLSA Status:	exempt

SUMMARY
Plans and directs activities of the Field Dept. by performing the following duties personally or through subordinate employees.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Works with the Marketing Director and the Director of Client Services to organize, schedule and perform the field collection of environmental samples in accordance with client project objectives and proper sampling protocols.

Ensures all Quality Assurance/Quality Control practices and procedures are followed by field personnel.

Identifies and addresses problems with staffing and instrumentation.

Enforces safety policies and ensures employee adherence to company policies and practices including, but not limited to, issues of client confidentiality and ethical and legal behavior.

Maintains an adequate supply of consumables for the Field Dept. Oversees the maintenance and upkeep of all department instrumentation and vehicles.

Reads and adheres to all company policies and procedures, including,. but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES
Directly supervises four employees in the Field Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include interviewing, hiring, and training employees; planning, assigning, and directing work; appraising performance; rewarding and disciplining employees; addressing complaints and resolving problems.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Associate's degree (A. A.) or equivalent from two-year college or technical school and a minimum of five years field experience; or a minimum of eight years related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read and interpret documents such as safety rules, operating and maintenance instructions, and procedure manuals. Ability to write routine reports and correspondence. Ability to speak effectively before groups of customers or employees of organization.

MATHEMATICAL SKILLS
Ability to calculate figures and amounts such as discounts, proportions, percentages, area, circumference, and volume. Ability to apply concepts of basic algebra and geometry.

REASONING ABILITY
Ability to apply common sense understanding to carry out instructions furnished in written, oral, or diagram form. Ability to deal with problems involving several concrete variables in standardized situations.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; walk; use hands to finger, handle, or feel; reach with hands and arms; and talk or hear. The employee is occasionally required to sit, climb or balance, and detect odors. The employee must frequently lift and/or move up to 100 pounds. Specific vision abilities required by this job include close vision, distance vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly exposed to outside weather conditions. The employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: October 14, 2002 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Director of Client Services
Department: Administration
Reports To: General Manager
FLSA Status: exempt

SUMMARY
Directs and coordinates office services and related activities, including developing and supervising programs for the maximum utilization of services and equipment by performing the following duties personally or through subordinate supervisors.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Supervises general front office and sample control staff and services.

Talks with customers by phone or in person and receives orders for service, discontinuance, or change in service.

Adjusts complaints concerning service rendered, referring complaints of service failures to designated departments for investigation.

Notifies clients of any abnormalities or departures from the conditions specified in the test method of any samples.

Coordinates clients needs with each departments and project managers.

Quotes prices to clients for services and determines special pricing.

Communicates and rectifies client concerns and issues to appropriate department in order to achieve customer satisfaction.

Negotiates purchase of office supplies and equipment and supervises receiving and shipping.

Supervises maintenance and alteration of office areas and equipment, as well as layout, arrangement, and housekeeping of office facilities.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

Enforces safety policies and procedures and insures employee adherence to company policies and practices including, but not limited to, issues of client confidentiality, and ethical and legal behavior.

SUPERVISORY RESPONSIBILITIES
Manages one lead person who supervises a total of four employees in Sample Control. Is responsible for the overall direction, coordination, and evaluation of this unit. Also directly supervises 12 non-

supervisory employees. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include interviewing, hiring, and training employees; planning, assigning, and directing work; appraising performance; rewarding and disciplining employees; addressing complaints and resolving problems.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) from four-year college or university; or one to two years related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret general business periodicals, professional journals, technical procedures, or governmental regulations. Ability to write reports, business correspondence, and procedure manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and the general public.

MATHEMATICAL SKILLS
Ability to calculate figures and amounts such as discounts, interest, commissions, proportions, percentages, area, circumference, and volume. Ability to apply concepts of basic algebra and geometry.

REASONING ABILITY
Ability to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Ability to interpret a variety of instructions furnished in written, oral, diagram, or schedule form.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to talk or hear. The employee is frequently required to stand; walk; sit; and use hands to access computer keyboard; reach with hands and arms; and taste or smell. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Angela Cossey
Prepared Date: October 18, 2002

E. S. Babcock & Sons, Inc
Job Description

Job Title: Assistant Microbiologist
Department: Microbiology Department
Reports To: Microbiology Department Supervisor
FLSA Status: nonexempt

SUMMARY
Conducts all microbiological tests of water and wastewater and analyzes data by performing the following duties. May also help plan and direct activities of the Microbiology Department.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Reviews test data, quality control and other laboratory information.

Helps ensure all regulatory and client project requirements are met.

Notifies clients and regulators promptly when bacteriological results are positive.
Interprets department results to clients.

Sets up laboratory equipment and instrumentation required for tests which have been assigned to technician.Verifies instrument calibration using known standards and criteria specified in standard operating procedures (SOP's).

Analyzes samples in accordance with SOP's. Documents results of analysis.

Prepares chemical solutions for use in analytical tests.

Keeps track of laboratory supplies needed for tests for which technician is responsible. Places orders for supplies needed in a timely manner.

Enters data in Laboratory Information Management System (LIMS).

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Associate's degree (A. A.) or equivalent from two-year college or technical school; or six months to one year related experience and/or training; or equivalent combination of education and experience.

Bachelor's degree (B. A.) from four-year college or university; or one to two years related experience

and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read and interpret documents such as safety rules, operating and maintenance instructions, and procedure manuals. Ability to write routine reports and correspondence.

MATHEMATICAL SKILLS
Ability to add, subtract, multiply, and divide in all units of measure, using whole numbers, common fractions, and decimals. Ability to compute rate, ratio, and percent and to draw and interpret graphs.

Ability to calculate figures and amounts such as discounts, interest, commissions, proportions, percentages, area, circumference, and volume. Ability to apply concepts of basic algebra and geometry.

REASONING ABILITY
Ability to apply common sense understanding to carry out instructions furnished in written, oral, or diagram form. Ability to deal with problems involving several concrete variables in standardized situations.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; use hands to manipulate glassware, instrumentation and enter data in computers; reach with hands and arms; talk or hear; and to detect odors. The employee is occasionally required to walk and sit. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, color vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals.
The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: October 1, 2002 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Chemist
Department: Chemistry Department
Reports To: Chemistry Supervisor
FLSA Status: nonexempt

SUMMARY

Conducts analysis of environmental samples for the purpose of reporting to laboratory clients by performing the following duties.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Sets up instrumentation and equipment required for tests. Verifies instrument calibrations and maintains instrument maintenance logs. Troubleshoots when necessary to identify and correct instrumentation or process problems.

Analyzes samples in accordance with Standard Operating Procedures (SOP's) and documents results of analysis. Verifies all batch quality control is within specifications and then enters data in Laboratory Information Management System (LIMS).

Monitors sample progress and workload to ensure samples are analyzed within regulatory holding times and that client project turnaround times are met.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES

Assists with the supervision of 1 to 3 laboratory technicians in the Chemistry Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include training employees; planning, assigning, and directing work; advising Supervisor on the quality and quantity of lab technicians' and assistants' work.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE

Bachelor's degree (B. A.) from four-year college or university; or minimum of 5 years environmental laboratory experience and/or training; or equivalent combination of education

and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret scientific periodicals, professional journals, technical procedures, or governmental regulations. Ability to write reports, business correspondence, and procedure manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and the general public.

MATHEMATICAL SKILLS
Ability to work with mathematical concepts such as probabilities and statistics Ability to apply concepts such as fractions, percentages, ratios, and proportions in laboratory calculations.

REASONING ABILITY
Ability to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Ability to interpret a variety of instructions furnished in written, oral, diagram, or schedule form.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; use hands to manipulate instrumentation and computers; reach with hands and arms; and talk or hear. The employee is occasionally required to walk, sit, and detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: October 14, 2002 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Supervisor (all groups)
Department: Chemistry Department
Reports To: Chemistry Department Manager
FLSA Status: exempt

SUMMARY
Oversees activites of the Chemistry Department, planned and directed by the Chemistry Department Manager, by performing the following duties personally or through subordinate employees.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Sets up instrumentation and equipment required for tests. Verifies instrument calibrations and maintains instrument maintenance logs. Troubleshoots when necessary to identify and correct instrumentation or process problems.

Analyzes samples using general lab techniques in accordance with Standard Operating Procedures (SOP's) and QC requirements and documents results of analysis. Verifies all batch quality control is within specifications and then enters data in Laboratory Information Management System (LIMS).

Maintains understanding of (LIMS) system and other software programs and levels of user proficiency.

Establishes goals and standards for subordinate personnel and schedules work load.

Identifies subordinates training needs and actively participates in their training process.

Conducts semi-annual performance reviews.

Assigns responsibilities to subordinates based on individual's skills and capabilities and follows up to ensure that desired result is achieved.

Verifies and reviews all data that is produced by metals department (Metals Group Assistant Supervisor only)
In the absence of the Data Validation Chemist, verifies and reviews all data that is produced by group (all groups EXCEPT metals group).

Monitors sample progress and workload to ensure samples are analyzed within regulatory holding times and that client project turnaround times are met.

Ensures all Quality Assurance/Quality Control practices and procedures are followed by laboratory personnel during shift. Reports any problems to the Chemistry Department Supervisor.

Identifies and addresses personnel and instrumentation issues and concerns during shift and reports findings to Chemistry Department Supervisor.

Possesses the ability to structure workday to effectively interact with subordinates and co-workers to sufficiently perform all assigned job duties and other miscellaneous tasks.

Possesses the ability to effectively lead and manage others while gaining cooperation of subordinates, co-workers, supervisors and upper management.

Follows direction from supervisor and shows commitment to meeting deadlines.

Has ability to give and receive constructive criticism and communicates well with others.

Contributes positively to company morale.

Identifies problems and uses appropriate resources to find solutions.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES
Assists with the supervision of all laboratory technicians and Chemists (within their group) in the Chemistry Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include training employees; directing work; appraising performance; rewarding and disciplining employees; addressing complaints and resolving problems (under the direction and supervision of the Chemistry Department Supervisor.)

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) from four-year college or university in Chemistry or related field and 3 years environmental laboratory experience; or minimum of 8 years environmental laboratory experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret scientific periodicals, professional journals, technical procedures, or governmental regulations. Ability to write reports, business correspondence, and procedure manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and the general public.

MATHEMATICAL SKILLS
Ability to apply advanced mathematical concepts such as exponents, logarithms, quadratic equations, and permutations. Ability to apply mathematical operations to such tasks as frequency distribution, determination of test reliability and validity, analysis of variance, correlation techniques, sampling theory, and factor analysis.

REASONING ABILITY
Ability to define problems, collect data, establish facts, and draw valid conclusions. Abiltiy to interpret an extensive variety of technical instructions in mathematical or diagram form and deal with several abstract and concrete variables.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to talk or hear. The employee frequently is required to stand; sit; and use hands to manipulate a computer keyboard and delicate instrumentation. The employee is occasionally requried to reach with hands and arms and detect odors. The employee must occasionally

lift and/or move up to 25 pounds. specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Angela Cossey
Date of Revision: June 13, 2005 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Senior Chemist
Department: Chemistry Department
Reports To: Chemistry Supervisor
FLSA Status: nonexempt

SUMMARY

Conducts analysis of environmental samples for the purpose of reporting to laboratory clients by performing the following duties.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Sets up instrumentation and equipment required for tests. Verifies instrument calibrations and maintains instrument maintenance logs. Troubleshoots when necessary to identify and correct instrumentation or process problems.

Analyzes samples in accordance with Standard Operating Procedures (SOP's) and documents results of analysis. Verifies all batch quality control is within specifications and then enters data in Laboratory Information Management System (LIMS).

Monitors sample progress and workload to ensure samples are analyzed within regulatory holding times and that client project turnaround times are met.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

SUPERVISORY RESPONSIBILITIES

Assists with the supervision of 1 to 3 laboratory technicians and 1 to 5 Chemists in the Chemistry Department. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws. Responsibilities include training employees; planning, assigning, and directing work; advising Supervisor on the quality and quantity of lab technicians' and assistants' work.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE

Bachelor's degree (B. A.) from four-year college or university and 5 years environmental

laboratory experience; or minimum of 11 years environmental laboratory experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret scientific periodicals, professional journals, technical procedures, or governmental regulations. Ability to write reports, business correspondence, and procedure manuals. Ability to effectively present information and respond to questions from groups of managers, clients, customers, and the general public.

MATHEMATICAL SKILLS
Ability to work with mathematical concepts such as probabilities and statistics. Ability to apply concepts such as fractions, percentages, ratios, and proportions in laboratory calculations.

REASONING ABILITY
Ability to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Ability to interpret a variety of instructions furnished in written, oral, diagram, or schedule form.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; use hands to manipulate instrumentation and computers; reach with hands and arms; and talk or hear. The employee is occasionally required to walk, sit, and detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: October 14, 2002 ac

E.S. Babcock and Sons, Inc.
Job Description

Job Title: Sample Receiving Assistant
Department: Sample Control Department
Reports To: Client Services Director
FLSA Status: nonexempt

SUMMARY
Responsible for all sample receiving, transportation and communication of client analysis requirements.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Greets and assists visitors and clients.

Assists Client Services Director with receipt of all samples submitted by courier or directly by client.

Verifies proper documentation and sample condition upon sample arrival.

Notifies client of any abnormalities or departures from the conditions specified in the test method of any samples.

Performs log-in of samples into the Laboratory Information Management System with complete information required to perform the appropriate test(s).

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follow all guidelines of the company safety training program.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Associate's degree (A. A.) or equivalent from two-year college or technical school; or six months to one year related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read and interpret documents such as safety rules, operating and maintenance instructions, and procedure manuals. Ability to write routine correspondence. Ability to speak effectively before groups of customers or employees of organization.

MATHEMATICAL SKILLS
Ability to add, subtract, multiply, and divide in all units of measure, using whole numbers, common fractions, and decimals. Ability to compute rate, ratio, and percent and to draw and interpret bar graphs.

REASONING ABILITY
Ability to apply common sense understanding to carry out instructions furnished in written, oral, or diagram form. Ability to deal with problems involving several concrete variables in standardized situations.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to talk or hear and detect odors. The employee frequently is required to stand; walk; sit; use hands to type on a keyboard and to reach with hands and arms. Specific vision abilities required by this job include close vision, depth perception, and ability to adjust focus. The employee must frequently lift and/or move up to 25 pounds and occasionally lift and/or move up to 50 pounds.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals.

The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: October 14, 2002

EDWARD S. BABCOCK AND SONS, INC.

DESCRIPTION OF DUTIES FOR CHIEF EXECUTIVE OFFICER

ALLISON MACKENZIE

The Chief Executive Officer is the senior executive for the Corporation and is responsible to report to the Board of Directors concerning all aspects of the operation of the business. The Chief Executive Officer is ultimately responsible to the Board of Directors for the performance of the business. The Chief Executive Officer is responsible for calling meetings of the Board of Directors and shareholders of the Corporation and communicating with the shareholders concerning the affairs of the Corporation at annual and special meetings.

The Chief Executive Officer is responsible for developing a strategy for the Corporation to identify and the risks and opportunities for the business, including asset and business acquisitions, as well as for securing the necessary credit and working capital to implement such strategy.

The Chief Executive Officer, in consultation with the Board of Directors, and management staff, sets policy objectives and strategy for the operation and expansion of the business, including the development of operating budgets, sales and profitability targets, product development, quality assurance and the development and retention of customer relationships.

The Chief Executive Officer also serves as the Chief Financial Officer and, in consultation with the Controller and any accounting and finance personnel, is responsible for managing and monitoring the financial assets and performance of the Corporation and for making adjustments as necessary during each fiscal year with respect to budgeted revenue and expenses.

The Chief Executive Officer directly supervises all other corporate officers and management personnel and is responsible for monitoring the job performance of such personnel, providing performance feedback and evaluations, and making recommendations to the Board of Directors regarding the hiring, termination and compensation of executive personnel.

The Chief Executive Officer is responsible for setting policy for the supervision, evaluation, retention and compensation of all non-management employees of the Corporation.

The Chief Executive Officer, in consultation with the management staff, supervises the day to day operation of the business of the Corporation and is responsible for taking action to correct any problems that may arise.

The Chief Executive Officer is the primary negotiator on behalf of the Corporation with respect to all material contracts and agreements which are entered into by the Corporation with its landlord, vendors, customers or other third parties, provided, however, that the CEO may delegate this authority as appropriate with respect to transactions or agreements that are entered into on an ongoing basis as part of the normal course of business.

The Chief Executive Officer is the public face of the business and is responsible for cultivating the reputation of the Corporation in the local communities where the Corporation operates, as well as the larger communities and markets in which the Corporation competes.

The Chief Executive Officer is responsible for ensuring that the Corporation is in compliance with its regulatory and legal obligations and acts as the point person for managing the legal and other professional advisors of the Corporation.

EDWARD S. BABCOCK AND SONS, INC.

DESCRIPTION OF DUTIES FOR CONTROLLER

MARIANNA ETCHEVERRIA

The Controller reports directly to the Chief Executive Officer and is responsible for the day to day management and operation of all accounting functions of the Business.

The Controller is responsible for managing the bank accounts and other financial assets of the Corporation and ensuring that such accounts and assets are properly used and accounted for.

The Controller is responsible for supervising accounting and administrative staff, including functions such as accounts payable, accounts receivable, bank reconciliation, payroll and collections.

The Controller is responsible for ensuring that all transactions are properly booked in the general ledger of the Corporation and for generating accurate financial statements and reports on an interim, monthly, quarterly and annual basis.

The Controller, in consultation with other management personnel, is responsible for developing performance measures for evaluating the profitability of the operations of the business and for budgeting and reconciliation.

The Controller is responsible for working with accounting and tax professionals to prepare all income, payroll and other tax returns required by the Corporation, subject to the review and approval of the Chief Executive Officer.

EDWARD S. BABCOCK AND SONS, INC.

DESCRIPTION OF DUTIES FOR LABORATORY TECHNICAL DIRECTOR

LAWRENCE CHRYSTAL

The Laboratory Technical Director reports directly to the Chief Executive Officer and is responsible for the technical operation of the laboratory operated by the Corporation.

The Laboratory Technical Director, in consultation with the Laboratory Director of Operations and the Chief Executive Officer, shares the responsibility for developing and implementing protocols for all laboratory functions and ensuring that testing performed in the laboratory conforms to recognized standards of accuracy and quality assurance.

Specifically, the Laboratory Technical Director is responsible for research and methods development for both existing fields of testing and new potential laboratory services. Regular methods review, improvements and modifications, in addition to regulatory literature reviews are the primary responsibility of the Technical Director.

The Laboratory Technical Director acts as a technical resource for laboratory staff and assists with method and instrument troubleshooting. The Director provides assistance to the Quality Assurance Manager with method and data quality issues, and makes recommendations. The Director is also a resource for Sales & Marketing, providing technical advise on proposals and client projects.

The Laboratory Technical Director is the interface between staff and the IT vendors. The Director has primary responsibility for the computerized integrity and format of the lab data, including final client deliverables.

The Laboratory Technical Director, in consultation with the Laboratory Director of Operations, the Chief Executive Officer and the Controller, is responsible for evaluating the feasibility and possible profitability of new fields of testing and proposed laboratory testing services.

EDWARD S. BABCOCK AND SONS, INC.

DESCRIPTION OF DUTIES FOR LABORATORY DIRECTOR (OPERATIONS)

The Laboratory Director reports directly to the Chief Executive Officer and is responsible for the day to day operation of the laboratory operated by the Corporation.

The Laboratory Director, in consultation with the Chief Executive Officer and the Laboratory Technical Director, is responsible for developing and implementing protocols for all laboratory functions and ensuring that testing performed in the laboratory conforms to recognized standards of accuracy and quality assurance.

Responsibilities include, but are not limited to the review of methods, testing, quality control and other operational reports to ensure that quality standards, regulatory requirements, efficiencies, and schedules are met. The Laboratory Director monitors contractual obligations and workload in conjunction with instrumentation and staffing to ensure adequate laboratory capacity.

Final Reporting includes:
- Data Validity & QC
- Report Format
- Method/Matrix Appropriate

Laboratory Capacity includes:
- Instrumentation and maintenance
- Laboratory supplies/consumables
- Staffing and scheduling

The Laboratory Director is responsible for maintaining all permits and certifications required by the Corporation to provide laboratory services. This includes both laboratory and personnel certifications and accreditations required for the services being provided.

The Laboratory Director is responsible for Laboratory staff development. This includes:
- Proper staff education and credentials
- Development and implementation of laboratory training programs
- Supervising the performance and evaluation of the laboratory staff
- Performance evaluations and disciplinary actions
- Hiring, termination and compensation of laboratory staff.
- Direct supervision and management of the Field Dept. Mgr., Microbiology Mgr., Inorganics Mgr., and Organics Mgr.

The Laboratory Director, in consultation with the Chief Executive Officer and Controller, is responsible for developing performance measures for evaluating the profitability of the laboratory operations, including budgeting and capital equipment needs. The Laboratory Director is also responsible for making recommendations regarding the pricing for laboratory and testing services.

The Laboratory Director participates in the strategic planning and implementation process, and is responsible for communicating and reinforcing strategic initiatives with staff.

E. S. Babcock & Sons, Inc.
Job Description

Job Title: Quality Assurance Manager
Department: Administration
Reports To: General Manager
FLSA Status: exempt

SUMMARY
Plans, coordinates, and directs all aspects of the laboratory assurance control program designed to ensure accuracy and validity of laboratory data and is responsible for the following duties personally or through subordinate supervisors.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Designs and implements the laboratory Quality Assurance/Quality Control (QA/QC) Program. Maintains and keeps current the Laboratory Quality Assurance Manual which documents the QA/QC Program. Reviews the program to ensure continuous improvement and modification. Formulates and maintains quality assurance objectives complementary to corporate policies and goals. Interprets quality assurance philosophy to key personnel in organization.

Designs and implements quality control training programs for laboratory personnel in conjunction with department supervisors. Works with Human Resources to develop a safety training program for all laboratory personnel.

Is responsible for the review of all quality control data and the preparation of quality control reports. Establishes all QC acceptance criteria. Notifies the analysts, department supervisors and Laboratory Technical Director of any QA/QC deficiencies promptly.

Has a general knowledge of all analytical test methods performed in the laboratory.

Initiates and manages all in-house and external proficiency testing samples. Reports external proficiency testing sample results to the appropriate agency in a timely fashion. Assists the Laboratory Technical Director in communications with regulatory agencies and accreditation programs.

Conducts internal audits of the laboratory at a minimum of once per calendar year and reports the results of the audit to the laboratory management.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality, as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

Ensures that all QA office functions remain independent of laboratory operations where QA oversight is provided

It is the policy of E. S. Babcock & Sons, Inc. that the QA Manager be allowed to evaluate data objectively without outside (e.g. managerial) influence. If the QA Manager feels that management is attempting to exert undue influence, this concern must be reported to the company Board of Directors immediately.

Enforces safety policies and procedures and insures employee adherence to company policies and practices including, but not limited to, issues of client confidentiality, and ethical and legal behavior.

SUPERVISORY RESPONSIBILITIES
Advises three subordinate supervisors who supervise a total of 35 employees in the Microbiology Department, Inorganic Chemistry Department, Organic Chemistry Department, and Field Operations Department. Is responsible for the overall direction, coordination, and evaluation of the quality control function of these units. Also directly supervises one to two employees. Carries out supervisory responsibilities in accordance with the organization's policies and applicable laws.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Master's degree (M. A.) and 2 years or more environmental laboratory experience, or equivalent; or six or more years related experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read, analyze, and interpret common scientific and technical journals, financial reports, and legal documents. Ability to respond to common inquiries or complaints from customers, regulatory agencies, or members of the business community. Ability to write speeches and articles for publication that conform to prescribed style and format. Ability to effectively present information to top management, public groups, and/or boards of directors.

MATHEMATICAL SKILLS
Ability to apply advanced mathematical concepts such as exponents, logarithms, quadratic equations, and permutations. Ability to apply mathematical operations to such tasks as frequency distribution, determination of test reliability and validity, analysis of variance, correlation techniques, sampling theory, and factor analysis.

REASONING ABILITY
Ability to define problems, collect data, establish facts, and draw valid conclusions. Ability to interpret an extensive variety of technical instructions in mathematical or diagram form and deal with several abstract and concrete variables.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is regularly required to sit and talk or hear. The employee frequently is required to use hands to type on a keyboard and handle glassware and delicate instrumentation, and to reach with hands and arms. The employee is occasionally required to stand, walk, and detect odors. Specific vision abilities required by this job include close vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Allison Mackenzie
Date of Revision: May 6, 2005 ac

E. S. Babcock & Sons, Inc.
Job Description

Job Title: QC Auditor
Department: Quality Assurance
Reports To: Quality Assurance Manager
FLSA Status: nonexempt

SUMMARY
Performs internal audits of all analytical methods in accordance with NELAP standards.

ESSENTIAL DUTIES AND RESPONSIBILITIES include the following. Other duties may be assigned.

Under the supervision of the Assistant QA Manager, conducts internal audits of each method at a minimum of once per year (or as needed).

- Verifies raw data and results completed by Chemist/Laboratory Technicians to ensure results are calculated properly and entered in Laboratory Information Management System (LIMS) correctly.
- Has adequate knowledge of laboratory techniques and ensures that co-workers are well trained and complying with laboratory techniques.
- Makes sure all documentation is done, i.e. dates, initials, qualifiers.
- Helps monitor that all required maintenance is performed and that maintenance logs are complete and up-to-date.
- Keeps Quality Assurance Manager informed of any employee not following proper laboratory techniques, documentation, or lab protocol.
- Uses audit process to identify training needs of analysis and educates co-workers on proper techniques, QC regulations and environmental relevance.

Maintains and updates SOP's to ensure that they accurately reflect lab practices and are compliant with method regulations.

Has adequate knowledge of all methods/SOP's/QC requirements and NELAP regulations.

Has extensive knowledge of Laboratory Information Management System (LIMS) and word processing software and serves as a resource for co-workers.

Has general knowledge of how to operate all equipment and instrumentation used by group.

Assists Quality Assurance department with miscellaneous required documentation.

Possesses the ability to appear for work on time and complete work schedule, while adhering to the meal and rest period policy, and effectively performs all assigned tasks as required of position.

Possesses the ability to effectively work and communicate with others while gaining cooperation of co-workers and supervisors.

Follows direction from supervisor and shows commitment to meeting deadlines.

Has the ability to receive constructive criticism.

Contributes positively to company morale.

Reads and adheres to all company policies and procedures, including, but not limited to, ethical and legal responsibilities, and the preservation of client confidentiality as set forth in the Edward S. Babcock & Sons, Inc. Employee and Quality Assurance Manuals, and follows all guidelines of the company safety training program.

QUALIFICATIONS To perform this job successfully, an individual must be able to perform each essential duty satisfactorily. The requirements listed below are representative of the knowledge, skill, and/or ability required. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

EDUCATION and/or EXPERIENCE
Bachelor's degree (B. A.) from four-year college or university and one year laboratory experience; or minimum of 6 years environmental laboratory experience and/or training; or equivalent combination of education and experience.

LANGUAGE SKILLS
Ability to read and interpret documents such as safety rules, operating and maintenance instructions, and procedure manuals. Ability to write routine reports and correspondence. Ability to speak effectively before groups of customers or employees of organization.

MATHEMATICAL SKILLS
Ability to work with mathematical concepts such as probability and statistical inference, and fundamentals of plane and solid geometry and trigonometry. Ability to apply concepts such as fractions, percentages, ratios, and proportions to practical situations.

REASONING ABILITY
Ability to solve practical problems and deal with a variety of concrete variables in situations where only limited standardization exists. Ability to interpret a variety of instructions furnished in written, oral, diagram, or schedule form.

PHYSICAL DEMANDS The physical demands described here are representative of those that must be met by an employee to successfully perform the essential functions of this job. Reasonable accommodations may be made to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is frequently required to stand; use hands to manipulate instrumentation and computers; reach with hands and arms; and talk or hear. The employee is occasionally required to walk, sit, and detect odors. The employee must occasionally lift and/or move up to 25 pounds. Specific vision abilities required by this job include close vision, peripheral vision, depth perception, and ability to adjust focus.

WORK ENVIRONMENT The work environment characteristics described here are representative of those an employee encounters while performing the essential functions of this job. Reasonable accommodations may be made

to enable individuals with disabilities to perform the essential functions.

While performing the duties of this job, the employee is occasionally exposed to toxic or caustic chemicals. The noise level in the work environment is usually moderate.

Job Description Prepared By: Angela Cossey
Date of Revision: October 18, 2005 ac

Appendix F Ethics and Data Integrity Manual

Code of Ethics

Edward S. Babcock & Sons, Inc is committed to ensuring the integrity of our data and meeting the quality needs of our clients. We pledge to manage our business according to the following principles:

- To produce results that are technically sound and legally defensible;
- To assert competency only for work for which adequate equipment and personnel are available;
- To present services in a confidential, honest, and forthright manner;
- To make every effort to establish a clear understanding with the client as to the extent and kind of services to be rendered;
- To provide employees with guidelines and an understanding of the ethical and quality standards required in the industry;
- To operate facilities in a manner that protects the environment and the health and safety of employees and the public;
- To obey all pertinent federal, state, and local laws and regulations;
- To continually seek ways to improve product service and quality;
- To treat employees equitably, acknowledge their scientific contributions, and provide them opportunities for growth and development;
- To recognize and respond to community concerns;
- To deal openly, honestly, and fairly in all business and financial matters with employees, clients, and the public.
- In addition to these values:
    - We share in each other's successes and challenges, and share the success and challenges of the company
    - We respect each employee's need for a balanced, complete and healthy life

- We respect each others cultural diversity and are tolerant and supportive of alternate lifestyles

Effective September 27, 2010
(This document supercedes all previous revisions of the Ethics Manual.)

ETHICS AND DATA INTEGRITY MANUAL

of

EDWARD S. BABCOCK AND SONS, INC
Located at: 6100 and 6110 Quail Valley Court, Riverside, CA 92507
Mailing address: PO Box 432, Riverside, CA 92502

Phone: (951) 653-3351

Approvals:

Allison Mackenzie
General Manager

Lawrence J. Chrystal
Laboratory Technical Director

Stacey A. Fry
QA Manager

Susann K. Thomas
Assistant QA Manager

Angela Cossey
Human Resources Manager

In addition to Project Managers, the above are the approved signatories for E.S. Babcock & Sons, Inc.
E.S. Babcock & Sons, Inc. has no parent corporation or subsidiaries and is located entirely at the above address.

TABLE OF CONTENTS

1 INTRODUCTION

This document outlines the Ethics and Data Integrity procedures implemented by **Edward S. Babcock and Sons, Inc.**, a privately owned environmental laboratory involved primarily in the testing of drinking water, wastewater, soils, and other matrices. This document describes the framework by which the laboratory establishes and maintains a documented Ethics and Data Integrity System appropriate to the type, range, and volume of environmental activities it undertakes. This document outlines the laboratory's policies and procedures established in order to meet the requirements set by the National Environmental Laboratory Accreditation Conference (NELAC) for National Environmental Laboratory Accreditation. It is the goal of Edward S. Babcock & Sons, Inc. to produce the highest-quality, most reliable environmental services and analytical data possible.

2 CODE OF ETHICS

Edward S. Babcock & Sons, Inc. is committed to ensuring the integrity of our data and meeting the quality needs of our clients. We pledge to manage our business according to the following principles:

- To produce results that are technically sound and legally defensible;
- To assert competency only for work for which adequate equipment and personnel are available;
- To present services in a confidential, honest, and forthright manner;
- To make every effort to establish a clear understanding with the client as to the extent and kind of services to be rendered;
- To provide employees with guidelines and an understanding of the ethical and quality standards required in the industry;
- To operate facilities in a manner that protects the environment and the health and safety of employees and the public;
- To obey all pertinent federal, state, and local laws and regulations;
- To continually seek ways to improve product service and quality;
- To treat employees equitably, acknowledge their scientific contributions, and provide them opportunities for growth and development;
- To recognize and respond to community concerns;

- To deal openly, honestly, and fairly in all business and financial matters with employees, clients, and the public.
- In addition to these values:
  - We share in each other's successes and challenges, and share the success and challenges of the company
  - We respect each employee's need for a balanced, complete and healthy life
  - We respect each others cultural diversity and are tolerant and supportive of alternate lifestyles.

3 HONOR CODE

Endeavor to always do the ***right*** thing.

4 WHY IS ETHICS IMPORTANT?

Here are some practical reasons for laboratory ethics and data integrity:

- Almost all environmental compliance and management decisions are based on measurement data (Analytical Excellence, Inc. Assuring Ethical Practices in the Environmental Laboratory).
- A reputation for honesty and integrity raises the credibility of the Profession (ACS: Chemists Code of Conduct).
- Ethical behavior is good for business; a laboratory lives and dies by its credibility and reputation.
- Coworkers must trust each other to perform their functions properly and work together successfully.
- Employees feel pride in their company if the company has a reputation for honesty and integrity.

5 WHAT IS DATA INTEGRITY?

Definition of Data Integrity
Data integrity is the process that maintains and ensures the data completeness and security. Secure data is protected from destruction and unauthorized or accidental access or revision (unaltered).

Here are some characteristics of data integrity:

- Data of known and documented quality
- Data whose authenticity can be relied upon
- Data with positive controls that demonstrate the data's authenticity and accuracy
- Complete and thorough documentation

It is the goal of the laboratory to set up systems, practices, and procedures to protect and assure the credibility, authenticity, and reliability of data.

6 WHAT IS FRAUD?

Definition of Laboratory Fraud
Laboratory Fraud is purposeful misrepresentation. Knowingly and intentionally presenting information or data in a manner that is not scientifically valid or in a manner not agreed upon either directly or implied by both the client and the laboratory.

What Constitutes Fraud in the Laboratory?
(Per EPA Guidance on Environmental Data Verification and Data Validation EPA QA/G-8)

- Making a false statement or representation
- Failure to analyze samples prior to reporting results (known as "drylabbing")
- Failure to conduct required analytical steps, as an example, reporting previously conducted successful QC results instead of conducting required QC analyses
- Manipulation of the sample prior to analysis in order to produce a desired analytical result, such as
  - Fortification of a sample with additional analyte (known as "juicing")
  - Undocumented dilution of a sample to produce lower results.
  - Injection of an increased amount of continuing calibration verification solution when recoveries were low when injecting the proper volume
- Manipulation of results during analysis, such as
  - Peak shaving or peak enhancement in order to obtain acceptable QC data

- ♦ Artificial manipulation of GC / MS tuning data to meet QC criteria
- ♦ Falsifying the date of analysis in the data system or bench sheet in order to meet holding times (time traveling)

- Post analysis alteration of results, such as
  - ♦ Transposition of figures to produce a desired result
  - ♦ Removal of manual integration flags from data
  - ♦ Incomplete documentation of corrective action taken. Any corrective action taken must be justified by laboratory guidelines (eg. SOP's) or approved by the supervisor or Quality Assurance Department. All actions and rationale must be fully documented.

Note: An honest error is **not** fraud.

7 INAPPROPRIATE OR IMPROPER PRACTICES WHICH CAN LEAD TO SUSPICION OF FRAUD

- Practices which are not technically sound
- Practices used to bypass required quality control parameters
- Practices used to change quality control results so they pass the control criteria
- Deviating from procedure documented in currently approved SOPs

8 ETHICS AND DATA INTEGRITY RESPONSIBILITIES

Administrative Responsibilities

- Create a strong ethics and data integrity program
- Provide training on ethics and data integrity
- Promptly investigate allegations of unethical behavior
- Maintain working conditions conducive to ethical behavior and proper data integrity

Supervisor Responsibilities

- Lead by example

- Ensure that employees understand ethics and data integrity policies and attend ethics and data integrity training
- Encourage open discussion of ethics and data integrity issues
- Support and assist with ethics investigations

Employee Responsibilities

- Follow SOP's and company policies
- Seek advice when course of action is unclear
- Ensure that you are properly trained and proficient in your job.
- Be cognizant of other employees actions – warn of danger of unethical behavior, report suspected unethical behavior
- Use stop-work authority, when working conditions threaten to become an ethical concern
- Present concerns regarding unethical behavior in an honest manner
- Cooperate with investigations and maintain confidentiality while an investigation is in progress

Any employee who is aware of unethical conduct within the laboratory is required to report it. Failure to report unethical behavior may result in the employee being an accomplice to the unethical behavior.

9 UNETHICAL BEHAVIOR

Pressures that could lead to unethical behavior can come from both internal and external sources.

Examples of External Pressures (clients):

- "The result is wrong – it is above my MCL. I will be fined."
- "It's only a little bit out – couldn't you round it?"
- "I'll go somewhere else if my results are too high."

Examples of Internal Pressures (employees / management):

- "If the QC fails, I will have to repeat it."
- "Get it out NOW!"
- "No time – I have personal plans."

10 CONFLICT OF INTEREST

Individuals may find themselves in situations where the possibility of a conflict may arise between their work responsibilities and the interests of the laboratory. It is recognized that Conflict of Interest may occur from time to time, but it is the responsibility of the employee to know how to recognize and disclose the situation appropriately.

The employees of E.S. Babcock & Sons, Inc. are to avoid the following:

- Assignment to different overlapping tasks, which may result in a conflict with work responsibilities.

  Example: Quality Assurance department personnel shall not perform any analyses that they are responsible for as an auditor. Doing so, would raise a conflict between the analyst's interest, which tends to favor practical procedure, and the auditor's interest, which tends to favor regulation and method protocol.

- Using their position and laboratory resources for personal gain for themselves or another person with whom they have personal, business, or financial ties.

  Example: When an employee accepts outside employment, the General Manager must be informed through the *Application for Approval of Outside Employment Form* (see Attachment #1) so the job may be checked for possible conflict of interest. Where conflict of interest occurs, the employee must choose whether to accept the outside employment or remain with E.S. Babcock & Sons, Inc.

  If, at a later date, the employee realizes a potential conflict of interest (i.e. the outside employer becomes a client of E. S. Babcock & Sons, Inc.), the employee must bring this information to the attention of management or face possible disciplinary action.

- Any outside activity which would prejudice their judgment.

  Example: Political views.

In all cases, individuals must be mindful to minimize conflict of interest, and management should be notified of all potential issues.

11 REPORTING PROCEDURES

Reporting Concerns
When reporting ethics and/or data integrity concerns, follow the chain of command. First, report to immediate supervisor. If the supervisor does not follow up, or is personally involved in the concern, then report concerns to the Laboratory Director and the Quality Assurance Manager. If there is belief that no action or inappropriate action is still an issue, report the concerns to the General Manager of the company. Also, the Human Resources Department is always available to address concerns.

Confidentiality
No employee will be disciplined for raising ethics and/or data integrity concerns. The employee's identity will be kept as confidential as possible during the course of the investigation into any allegations. If the investigation uncovers illegal activities, all information will be submitted to criminal investigators.

12 ETHICS AND DATA INTEGRITY TRAINING

Initial ethics and data integrity training are conducted for new hires during orientation. This training is an orientation to this manual. The new employee takes and passes an ethics quiz (see Attachment #2) and signs a Statement of Ethics Form (see Attachment #3).

On a yearly basis, all employees sign a Statement of Ethics Form (see Attachment #3). Once a year all employees will undergo ethics and data integrity training and the training participants are expected to complete an Annual Ethics and Data Integrity Manual Signature Statement and Training Certificate (see Attachment #6). Additional training is offered during the year if any ethics and/or data integrity related issues arise.

13 PROACTIVE FRAUD PREVENTION AND DETECTION

The laboratory has practices in place for the prevention and detection of fraud via a system of reviews, in addition to the ongoing data review procedures. A Quality Assurance Method Audit is scheduled to occur on an annual basis for all applicable NELAP analyses. All reviews are fully documented and, at the discretion of the auditor, may include a Laboratory Practices Review of the electronic data (see Laboratory Practices Review- Attachment #5).

The following are "suggestions for auditors" per EPA Guidance on Environmental Data Verification and Data Validation EPA QA/G-8):

- Routine spot-checking of manual integration utilized by the analysts. Are there repeated manual integrations – especially of QC data? A periodic (at least annual) audit of manual integration by supervisors/management is also suggested.

- Periodically, peer reviewers should verify that reported dates in a data package are consistent. Does the date of analysis precede the date of extraction? This would raise the possibility of "time traveling".

- Are there overlapping analysis times for the same instrument? This suggests the possibility of "drylabbing".

- Is there a pattern of high response factors for compounds where relatively low response factors are expected? This suggests the possibility of "juicing".

- Is there an indication that tuning or calibration dates may have been manipulated? For example, does the raw data indicate numerous computer operations associated with the tuning or calibration? Is there a possibility that an adjacent peak was "borrowed" in lieu of legitimate background subtraction procedures? If so, this raises questions about the analyst's performance and may suggest the use of improper practices.

- Are there erasures, whiteouts, and handwritten changes in the batch data? Are all changes properly documented and dated? Improperly documented changes may suggest improper manipulation of results.

- Is the QC data relevant and associated with the field sample data under review? The analyst may be attempting to hide out-of-control performance.

- Is there any indication that the analyst is selectively choosing desirable QC results while suppressing other data? If so, the analyst may be establishing improper calibration curves, or batch acceptance.

14 INTERACTION WITH GOVERNMENT AUDITORS

There are two types of government audits: biennial accreditation audits and those audits in response to suspected ethics violations.

Employee responsibilities during a government audit are as follows:

- Answer all questions honestly
- If you do not know the answer, say "I don't know."
- NEVER make up answers, hoping you guess correctly.

15 RESPONSE TO ETHICAL AND DATA INTEGRITY ISSUES

When an employee brings ethics and/or data integrity concerns to the attention of supervisors or management, there are several types of responses that may occur. If the answer is immediately known, the employee will be advised as to what action to take in

the situation. If the answer is not immediately known, the supervisors and/or management will investigate the concern and determine what advice to give at a later time.

An ESB Quality Control Follow-up Report may be used to document challenges presented to the Ethics and Data Integrity Program.

If any possibility of serious potential unethical behavior has been raised, an official Ethics Investigation will be initiated. This investigation may occur immediately or may be prompted by the findings from an ESB Quality Control Follow-up Report. There are two types of investigations:

- Type 1: Actions covering possible illegalities. If the laboratory investigation uncovers illegalities or potential illegalities, any information uncovered will be turned over to outside criminal investigators. The management and employees will fully cooperate with any outside criminal investigation.

- Type 2: Serious actions, but not covering possible illegalities – potentially an embarrassment to the lab.

For each type of Ethics Investigation, a committee will be chosen by the Laboratory Director to conduct an investigation. The committee will be comprised of the Laboratory Director, or his designated alternate from upper management, one member from the supervisory level and one member from the peer level (see Attachment #4). The Human Resources Manager will be available to serve on or advise the committee. Each committee member will not be directly affiliated with the alleged ethics and/or data integrity concern or violation. All findings and recommendations will be reported to the President.

The committee will take every measure possible to protect the confidentiality of any employee who has raised any ethics and/or data integrity concerns that trigger investigations.

16 ETHICS DISCIPLINE

All factors must be weighed before determining discipline. The discipline may vary from a warning to termination of employment. Knowingly falsifying data is grounds for immediate termination of employment, and possible criminal litigation.

Assessing Employee Responsibility

- Did the employee know the right action?

- Did the employee have adequate instructions?

- Did the action appear to be intentional?

- Was the employee instructed to take the wrong action?
- What was the severity of the violation?
- Was there any prior history of discipline involving the affected individual or the supervisor/manager for ethics violations?

Assessing Management's Responsibility

- Did management direct or in any way condone the wrong action?
- Were there indicators of potential wrongdoing that were either missed or ignored?
- Were there any conflicting practices or policies?

17 ATTACHMENTS

(1) Application for Approval of Outside Employment
(2) Ethics and Data Integrity Quiz
(3) Statement of Ethics and Data Integrity
(4) Approved Ethics and Data Integrity Investigation Committee Members
(5) Laboratory Practices Review
(6) Annual Ethics and Data Integrity Manual Signature Statement and Training Certificate

Application for Approval of Outside Employment

To be completed when an employee of Edward S. Babcock & Sons, Inc. would like to seek outside employment in addition to their current responsibilities.

Employee Information

Name: _____

Current Job Title: _____

Date: _____

Outside Employment Information

Name of Company: _____

Address: _____

Phone Number: _____

Contact Person: _____

Job Title: _____

For Administrative Use Only

☐ **Application approved**

☐ **Application denied**

_____ _____

Signature of General Manager **Date**

Ethics and Data Integrity Quiz

Name: _____

Date: _____

1. What is Laboratory Fraud?

2. Where do pressures for unethical behavior come from?

3. What are the employee's ethics responsibilities?

4. What constitutes a conflict of interest?

5. What is the policy when obtaining outside employment?

Ethics and Data Integrity Quiz (con't)

6. How do you report ethics concerns?

7. What are the rules for interacting with government auditors?

8. Describe the two types of investigations.

9. Name three types of unethical behavior in the laboratory described in the Proactive Program for Prevention & Detection of Unethical Practices.

10. In an investigation that determines unethical behavior, what factors will be considered in determining the type of disciplinary action taken?

Edward S. Babcock & Sons, Inc.
6100 & 6110 Quail Valley Court, Riverside, CA 92507

Statement of Ethics and Data Integrity

I understand the following:

1) All analytical results are to be presented as honestly and accurately as possible.

2) Analytical difficulties are to be dealt with in a forthright manner. Any errors that affect an analysis must be brought to the attention of management as soon as discovered.

3) Data may not in any way be changed or deleted. Any data corrections must be clearly documented – showing both the original data and the correction with date and initials of the person making the correction, plus a discussion of the reason for the change whenever the reason is not readily apparent.

4) Falsification of data is grounds for immediate termination of employment.

5) Failure to follow the policies, procedures and ethical standards set by Edward S. Babcock & Sons, Inc. is grounds for immediate termination in addition to possible civil or criminal charges.

I also understand that failure to comply with the above will result in disciplinary action up to and including termination of employment.

_____ _____

Signature of Employee Date

_____

Name of Employee *(Please print clearly.)*

_____ _____

Signature of Witness Date

Approved Ethics and Data Investigation Committee Members

Laboratory Director (or his designated alternate from upper management)

Supervisory Level Committee Member (select one):

- Field Manager
- Inorganics Manager
- Organics Manager
- Bacti Manager
- Office Manager
- QA Manager

Peer Level Committee Member (select one):

- Field Staff
- Inorganics Staff
- Organics Staff
- Bacti Staff
- Office Staff
- QA Staff

Optional Participant:

- Human Resources Manager

Laboratory Practices Review – Electronic Audit

Instrument: _____

Method: _____

Analyst: _____

Reviewer: _____

Date of Review: _____

The following questions apply to instrumental analyses – especially to chromatographic methods such as IC, HPLC, GC, and GCMS. Not all items will apply to other types of methods. See Ethics Manual for further information. Circle Y for Yes, N for No.
If answers lead to further investigation or require an explanation, add notes on page 3.

1. **Batch/Samples:**
   Go into Element (the LIMS) and select a recent batch that is reviewed:

   Batch:_____ Date of Batch:_____

   Pick a few random samples and verify the time of analysis and results between the data collection software and LIMS:

   _____

   _____

   _____

   Are the reported dates in a data package consistent (does the date of the analysis precede the date of extraction, is the time between sample at least as long as a run) ? **Y / N**
   Are there overlapping analysis times for the same instrument? **Y / N**

2. **Blank:**
   View the calibration associated with that batch on the computer.
   Is there an indication that blank data may have been manipulated? **Y / N / NA**

   _____

3. **Calibrations:**
   View the calibration associated with that batch on the computer.

Verify the data points used to create the calibrations and that the curve looks appropriate.
Okay? **Y / N**
Verify that this was the calibration used on the samples in the batch (give the date).
Okay? **Y / N** _____
Is there an indication that calibration data may have been manipulated? **Y / N**
Is there an indication that tuning data may have been manipulated? **Y / N / NA**

---

4. **Integration:**
Look closely at the most difficult calibration point (such as the low calibrator).
Integration okay? **Y / N**
Are manual integrations obviously noted and appropriate? **Y / N / NA**
Are there repeated manual integrations – especially of QC data? **Y / N**
If yes,
a) Does it appear the peaks were reintegrated to achieve some preset criteria? **Y / N**
b) Were manually integrated peaks obviously indicated? **Y / N**

---

5. **Quality Control Samples**:
Were the operating conditions for the QC samples and client samples different (are the run lengths the same)? **Y / N**
Is there any indication that the analyst is running extra QC? **Y / N**
If yes, are they selectively choosing desirable QC results while suppressing other data? **Y / N**
If yes, is the selection within acceptable laboratory practices and/or decision making and is the reasoning well documented? **Y / N**
Is there a pattern of high response factors for compounds where relatively low response factors are expected? **Y / N / NA**
Is the response of the LCS consistent between batches (check a previous batch)? ? **Y / N**

---

6. **Data Back-up:**
Do full sets of hard copies also exist (meaning that soft copies are not the official back-up)? **Y / N**
Is the electronic data backed-up? **Y / N**
If yes,
How is the electronic data backed-up?_____
How often is the electronic data backed-up?_____
Are the files write-protected? ? **Y / N**
Where are the back-ups stored?_____

---

7. Comments and Notes:

Edward S. Babcock & Sons, Inc.
6100 & 6110 Quail Valley Court, Riverside, CA 92507

Annual Ethics and Data Integrity

Manual Signature Statement

and Training Certificate

I have been informed of any changes taking effect on the *Ethics and Data Integrity Manual* Dated: 9/27/2010.

I acknowledge and understand the contents of this document.

(Note: I have already completed the Ethics Quiz and Statement of Ethics Form as part of my initial ethics and data integrity training.)

I have received and completed my annual on-line training on ethics and data integrity training

Date: _____ *Trainer/PresentationCreator:* Susann Thomas .

The contents of this annual training session included:
A review of the changes in the *Ethics and Data Integrity Manual.*
A Review of the Code of Ethics and Data Integrity.
A review on how to make ethical decisions including situational examples.
General discussion and trainee input.

I understand that I must also sign a new Statement of Ethics Form each year to renew my commitment to the lab.

_____ _____
Signature of Employee Date

_____
Name of Employee *(Please print clearly.)*

Appendix G References for QA Procedures

REFERENCES FOR QA PROCEDURES

United States Environmental Protection Agency, Office of Solid Waste and Emergency Response. *Test methods for Evaluating Solid Waste,* November 1986, SE-846, Third Edition, Washington, D.C.

United States Environmental Protection Agency, Health Effects Research Laboratory. *Manual for Analytical Quality Control for Pesticides and Related Compounds in Human and Environmental Samples*, January 1979, EPA -600/1-79-008, First Revision, Research Triangle Park, N.C.

United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory. *Handbood for Analytical Quality Control in Water and Wastewater Laboratories*, March 1979, EPA-600/4-79-0 19, Cincinnati, OH.

National Environmental Laboratory Accreditation Conference. *NELAC Standard,* June 2003, EPA-600/R-04/003.

ISO/IEC 17025 International Standard. *General Requirements for the Competence of Testing and Calibration Laboratories, 2005.*

AOAC International Guidelines for Laboratories Performing Microbiological and Chemical Analysis of Food and Pharmaceuticals, March 2010

Appendix H References for Sampling Procedures

References for Sampling Procedures

United States Environmental Protection Agency, Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste, Volume II: Field Manual Physical/Chemical Methods*, November, 1986, SW-846, Third Edition, Washington D.C.

United States Environmental Protection Agency, Environmental Monitoring and Support Laboratory. *Handbook for Sampling and Sample Preservation of Water and Wastewater,* September 1982, EPA-600/4-82-029, Cincinnati, OH.

Appendix I NELAC and ISO 17025 Quality System Information

National Environmental
Laboratory **Accreditation**
Conference

nelac

QUALITY SYSTEMS

Approved June 5, 2003
Effective July 1, 2005

2003 NELAC Standard

Note that the NELAC standards now have two significant dates: 1) the date the standards were approved at the annual meeting, and 2) the date the standards are effective and must be implemented. This is especially important as some portions of the standards have different effective dates. The approval date is part of the document control header on each page. The cover of each chapter shows both the approval date and the effective date. Changes approved for implementation at a time other than the effective date (on the chapter cover) are noted in the chapter, showing the approved text and its effective date.

TABLE OF CONTENTS
QUALITY SYSTEMS

Pages 9 through 13 ommited intentionally from this appendix. For full text, please see the QA Department.

5.0 QUALITY SYSTEMS

INTRODUCTION

Each laboratory shall have a quality system. The laboratory's quality system is the process by which the laboratory conducts its activities so as to provide the client with data of known and documented quality with which to demonstrate regulatory compliance and for other decision-making purposes. This system includes a process by which appropriate analytical methods are selected, their capability is evaluated and their performance is documented. The quality system shall be documented in the laboratory's quality manual.

This chapter contains detailed quality system requirements for consistent and uniform implementation by both the laboratories conducting testing under these standards and the evaluation of those laboratories by accrediting authorities. Each laboratory seeking accreditation under NELAP must assure that they are implementing their quality system and that all Quality Control (QC) procedures specified in this chapter are being followed. The Quality Assurance (QA) policies, which establish QC procedure, are applicable to environmental laboratories regardless of size and complexity.

The growth in use of quality systems generally has increased the need to ensure that laboratories which form part of larger organizations or offer other services can operate to a quality system that is seen as compliant with ISO 9001 or ISO 9002 as well as with this Standard. Care has been taken, therefore, to incorporate all those requirements of ISO 9001 and ISO 9002 that are relevant to the scope of environmental testing services that are covered by the laboratory's quality system.

Environmental testing laboratories that comply with this Standard will therefore also operate in accordance with ISO 9001 or ISO 9002.

Certification against ISO 9001 and ISO 9002 does not of itself demonstrate the competence of the laboratory to produce technically valid data and results.

Chapter 5 is organized according to the structure of ISO/IEC 17025, 1999. Where deemed necessary, specific areas within this Chapter may contain more information than specified by ISO/IEC 17025.

All items identified in this Chapter shall be available for on-site inspection and data audit.

5.1 SCOPE

5.1.1 This Standard specifies the general requirements for the competence to carry out environmental tests, including sampling. It covers testing performed using standard methods, non-standard methods, and laboratory-developed methods.

It contains all of the requirements that environmental testing laboratories have to meet if they wish to demonstrate that they operate a quality system, are technically competent, and are able to generate technically valid results.

If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory shall demonstrate that such requirements are met. If it is not clear

which requirements are more stringent, the standard from the method or regulation is to be followed. (See the supplemental accreditation requirements in Section 1.8.2.)

5.1.2 This Standard is applicable to all organizations performing environmental tests. These include, for example, first-, second- and third-party laboratories, and laboratories where environmental testing forms part of inspection and product certification.

This Standard is applicable to all laboratories regardless of the number of personnel or the extent of the scope of environmental testing activities. When a laboratory does not undertake one or more of the activities covered by this Standard, such as sampling and the design/development of new methods, the requirements of those clauses do not apply.

5.1.3 The notes given provide clarification of the text, examples and guidance. They do not contain requirements and do not form an integral part of this Standard.

5.1.4 This Standard is for use by laboratories in developing their quality, administrative and technical systems that govern their operations. Laboratory clients, regulatory authorities and accreditation authorities may also use it in confirming or recognizing the competence of laboratories.

This Standard includes additional requirements and information for assessing competence or for determining compliance by the organization or accrediting authority granting the recognition (or approval).

5.1.5 Compliance with regulatory and safety requirements on the operation of laboratories is not covered by this Standard. It is the laboratory's responsibility to comply with the relevant health and safety requirements.

5.1.6 If environmental testing laboratories comply with the requirements of this Standard, they will operate a quality system for their environmental testing activities that also meets the requirements of ISO 9001 when they engage in the design/development of new methods, and/or develop test programs combining standard and non-standard test and calibration methods, and ISO 9002 when they only use standard methods. ISO/IEC 17025 covers several technical competence requirements that are not covered by ISO 9001 and ISO 9002.

5.1.7 An integral part of a Quality System is the data integrity procedures. The data integrity procedures provide assurance that a highly ethical approach to testing is a key component of all laboratory planning, training and implementation of methods. The following sections in this standard address data integrity procedures:

Management Responsibilities	5.4.2.6, 5.4.2.6.1, and 5.4.2.6.2
Training	5.5.2.7
Control and Documentation	5.4.15

5.2 REFERENCES

See Appendix A.

5.3 TERMS AND DEFINITIONS

The relevant definitions from ISO/IEC Guide 2, ANSI/ASQC E-4 (1994), and the International vocabulary of basic and general terms in metrology (VIM) are applicable, the most relevant being quoted in Appendix A, Glossary, of Chapter 1 together with further definitions applicable for the purposes of this Standard. General definitions related to quality are given in ISO 8402, whereas ISO/IEC Guide 2 gives definitions specifically related to standardization, certification, and laboratory accreditation. Where different definitions are given in ISO 8402, the definitions in ISO/IEC Guide 2 and VIM are preferred.

See Appendix A, Glossary, of Chapter 1.

5.4 MANAGEMENT REQUIREMENTS

5.4.1 Organization

5.4.1.1 The laboratory or the organization of which it is part shall be an entity that can be held legally responsible.

5.4.1.2 It is the responsibility of the laboratory to carry out its environmental testing activities in such a way as to meet the requirements of this Standard and to satisfy the needs of the client, the regulatory authorities or organizations providing recognition.

5.4.1.3 The laboratory management system shall cover work carried out in the laboratory's permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

5.4.1.4 If the laboratory is part of an organization performing activities other than environmental testing, the responsibilities of key personnel in the organization that have an involvement or influence on the environmental testing activities of the laboratory shall be defined in order to identify potential conflicts of interest.

a) Where a laboratory is part of a larger organization, the organizational arrangements shall be such that departments having conflicting interests, such as production, commercial marketing or financing do not adversely influence the laboratory's compliance with the requirements of this Standard.

b) The laboratory must be able to demonstrate that it is impartial and that it and its personnel are free from any undue commercial, financial and other pressures which might influence their technical judgment. Environmental testing laboratories shall not engage in any activities that may endanger the trust in its independence of judgment and integrity in relation to its environmental testing activities.

5.4.1.5 The laboratory shall:

a) have managerial and technical personnel with the authority and resources needed to carry out their duties and to identify the occurrence of departures from the quality system or from the procedures for performing environmental tests, and to initiate actions to prevent or minimize such departures (see also 5.5.2);

b) have processes to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work;

c) have policies and procedures to ensure the protection of its clients' confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results.

The policy and procedures to ensure the protection of clients' confidential information and proprietary rights may not apply to in-house laboratories.

d) have policies and procedures to avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgment or operational integrity;

e) define the organization and management structure of the laboratory, its place in any parent organization, and the relationships between quality management, technical operations and support services;

f) specify the responsibility, authority and interrelationships of all personnel who manage, perform or verify work affecting the quality of the environmental tests.

Documentation shall include a clear description of the lines of responsibility in the laboratory and shall be proportioned such that adequate supervision is ensured;

g) provide adequate supervision of environmental testing staff, including trainees, by persons familiar with methods and procedures, purpose of each environmental test, and with the assessment of the environmental test results;

h) have technical management which has overall responsibility for the technical operations and the provision of the resources needed to ensure the required quality of laboratory operations;

The technical director(s) (however named) shall certify that personnel with appropriate educational and/or technical background perform all tests for which the laboratory is accredited. Such certification shall be documented.

The technical director(s) shall meet the requirements specified in the Accreditation Process. (see 4.1.1.1)

i) appoint a member of staff as quality manager (however named) who, irrespective of other duties and responsibilities, shall have defined responsibility and authority for ensuring that the quality system is implemented and followed at all times; the quality manager shall have direct access to the highest level of management at which decisions are made on laboratory policy or resources;

Where staffing is limited, the quality manager may also be the technical director or deputy technical director;

The quality manager (and/or his/her designees) shall:

1) serve as the focal point for QA/QC and be responsible for the oversight and/or review of quality control data;

2) have functions independent from laboratory operations for which they have quality assurance oversight;

3) be able to evaluate data objectively and perform assessments without outside (e.g., managerial) influence;

4) have documented training and/or experience in QA/QC procedures and be knowledgeable in the quality system as defined under NELAC;

5) have a general knowledge of the analytical test methods for which data review is performed;

6) arrange for or conduct internal audits as per 5.4.13 annually; and,

7) notify laboratory management of deficiencies in the quality system and monitor corrective action.

j) appoint deputies for key managerial personnel. Including the technical director(s) and/or quality-manager;

k) for purposes of qualifying for and maintaining accreditation, each laboratory shall participate in a proficiency test program as outlined in Chapter 2.

5.4.2 Quality System

5.4.2.1 The laboratory shall establish implement and maintain a quality system based on the required elements contained in this chapter and appropriate to the type, range and volume of environmental testing activities it undertakes. The laboratory shall document its policies, systems, programs, procedures and instructions to the extent necessary to assure the quality of the environmental test results. The system's documentation shall be communicated to, understood by, available to, and implemented by the appropriate personnel.

5.4.2.2 The laboratory's quality system policies and objectives shall be defined in a quality manual (however named). The overall objectives shall be documented in a quality policy statement. The quality policy statement shall be issued under the authority of the chief executive. It shall include at least the following:

a) the laboratory management's commitment to good professional practice and to the quality of its environmental testing in servicing its clients; The laboratory shall define and document its policies and objectives for, and its commitment to accepted laboratory practices and quality of testing services.

b) the management's statement of the laboratory's standard of service;

c) the objectives of the quality system;

The laboratory management shall ensure that these policies and objectives are documented in a quality manual.

d) a requirement that all personnel concerned with environmental testing activities within the laboratory familiarize themselves with the quality documentation and implement the policies and procedures in their work; and

e) the laboratory management's commitment to compliance with this Standard.

5.4.2.3 The quality manual shall include or make reference to the supporting procedures including technical procedures. It shall outline the structure of the documentation used in the quality system.

The quality manual, and related quality documentation, shall state the laboratory's policies and operational procedures established in order to meet the requirements of this Standard.

Where a laboratory's quality manual contains the necessary requirements, a separate SOP or policy is not required.

The quality manual shall list on the title page: a document title; the laboratory's full name and address; the name, address (if different from above), and telephone number of individual(s) responsible for the laboratory; the name of the quality manager (however named); the identification of all major organizational units which are to be covered by this quality manual and the effective date of the version;

The quality manual and related quality documentation shall also contain:

a) a quality policy statement, including objectives and commitments, by top management (see 5.4.2.2);

b) the organization and management structure of the laboratory, its place in any parent organization and relevant organizational charts;

c) the relationship between management, technical operations, support services and the quality system;

d) procedures to ensure that all records required under this Chapter are retained, as well as procedures for control and maintenance of documentation through a document control system which ensures that all standard operating procedures (SOPs), manuals, or documents clearly indicate the time period during which the procedure or document was in force;

e) job descriptions of key staff and reference to the job descriptions of other staff;

f) identification of the laboratory's approved signatories; at a minimum, the title page of the Quality Manual must have the signed and dated concurrence, (with appropriate titles) of all responsible parties including the quality manager(s), technical director(s), and the agent who is in charge of all laboratory activities such as the laboratory director or laboratory manager;

g) the laboratory's procedures for achieving traceability of measurements;

h) a list of all test methods under which the laboratory performs its accredited testing;

i) mechanisms for ensuring that the laboratory reviews all new work to ensure that it has the appropriate facilities and resources before commencing such work;

j) reference to the calibration and/or verification test procedures used;

k) procedures for handling submitted samples;

l) reference to the major equipment and reference measurement standards used as well as the facilities and services used by the laboratory in conducting tests;

m) reference to procedures for calibration, verification and maintenance of equipment;

n) reference to verification practices which may include interlaboratory comparisons, proficiency testing programs, use of reference materials and internal quality control schemes;

o) procedures to be followed for feedback and corrective action whenever testing discrepancies are detected, or departures from documented policies and procedures occur;

p) the laboratory management arrangements for exceptionally permitting departures from documented policies and procedures or from standard specifications;

q) procedures for dealing with complaints;

r) procedures for protecting confidentiality (including national security concerns), and proprietary rights;

s) procedures for audits and data review;

t) processes/procedures for establishing that personnel are adequately experienced in the duties they are expected to carry out and are receiving any needed training;

u) reference to procedures for reporting analytical results; and,

v) a Table of Contents, and applicable lists of references and glossaries, and appendices.

5.4.2.4 The roles and responsibilities of technical management and the quality manager, including their responsibility for ensuring compliance with this Standard, shall be defined in the quality manual.

5.4.2.5 The quality manual shall be maintained current under the responsibility of the quality manager.

5.4.2.6 The laboratory shall establish and maintain data integrity procedures. These procedures shall be defined in detail within the quality manual. There are four required elements within a data integrity system. These are 1) data Integrity training, 2) signed data integrity documentation for all laboratory employees, 3) in-depth, periodic monitoring of data integrity, and 4) data integrity

procedure documentation. The data integrity procedures shall be signed and dated by senior management. These procedures and the associated implementation records shall be properly maintained and made available for assessor review. The data integrity procedures shall be annually reviewed and updated by management.

5.4.2.6.1 Laboratory management shall provide a mechanism for confidential reporting of data integrity issues in their laboratory. A primary element of the mechanism is to assure confidentiality and a receptive environment in which all employees may privately discuss ethical issues or report items of ethical concern.

5.4.2.6.2 In instances of ethical concern, the mechanism shall include a process whereby laboratory management are to be informed of the need for any further detailed investigation.

5.4.3 Document Control

5.4.3.1 General

The laboratory shall establish and maintain procedures to control all documents that form part of its quality system (internally generated or from external sources). Documents include policy statements, procedures, specifications, calibration tables, charts, textbooks, posters, notices, memoranda, software, drawings, plans, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written.

The control of data related to environmental testing is covered in 5.5.4.7. The control of records is covered in 5.4.12.

5.4.3.2 Document Approval and Issue

5.4.3.2.1 All documents issued to personnel in the laboratory as part of the quality system shall be reviewed and approved for use by authorized personnel prior to issue. A master list or an equivalent document control procedure identifying the current revision status and distribution of documents in the quality system shall be established and be readily available to preclude the use of invalid and/or obsolete documents.

5.4.3.2.2 The procedure(s) adopted shall ensure that:

a) authorized editions of appropriate documents are available at all locations where operations essential to the effective functioning of the laboratory are performed;

b) documents are periodically reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements;

c) invalid or obsolete documents are promptly removed from all points of issue or use, or otherwise assured against unintended use;

d) obsolete documents retained for either legal or knowledge preservation purposes are suitably marked.

5.4.3.2.3 Quality system documents generated by the laboratory shall be uniquely identified. Such identification shall include the date of issue and/or revision identification, page numbering,

the total number of pages or a mark to signify the end of the document, and the issuing authority(ies).

5.4.3.3 Document Changes

5.4.3.3.1 Changes to documents shall be reviewed and approved by the same function that performed the original review unless specifically designated otherwise. The designated personnel shall have access to pertinent background information upon which to base their review and approval.

5.4.3.3.2 Where practicable, the altered or new text shall be identified in the document or the appropriate attachments.

5.4.3.3.3 If the laboratory's documentation control system allows for the amendment of documents by hand, pending the re-issue of the documents, the procedures and authorities for such amendments shall be defined. Amendments shall be clearly marked, initialed and dated. A revised document shall be formally re-issued as soon as practicable.

5.4.3.3.4 Procedures shall be established to describe how changes in documents maintained in computerized systems are made and controlled.

5.4.4 Review of Requests, Tenders and Contracts

5.4.4.1 The laboratory shall establish and maintain procedures for the review of requests, tenders and contracts. The policies and procedures for these reviews leading to a contract for environmental testing shall ensure that:

a) the requirements, including the methods to be used, are adequately defined, documented and understood (see 5.5.4.2);

b) the laboratory has the capability and resources to meet the requirements;

The purpose of this review of capability is to establish that the laboratory possesses the necessary physical, personnel and information resources, and that the laboratory's personnel have the skills and expertise necessary for the performance of the environmental tests in question. The review may encompass results of earlier participation in interlaboratory comparisons or proficiency testing and/or the running of trial environmental test programs using samples or items of known value in order to determine uncertainties of measurement, detection limits, confidence limits, or other essential quality control requirements. The current accreditation status of the laboratory must also be reviewed. The laboratory must inform the client of the results of this review if it indicates any potential conflict, deficiency, lack of appropriate accredtation status, or inability on the laboratory's part to complete the client's work.

c) the appropriate environmental test method is selected and capable of meeting the clients' requirements (see 5.5.4.2).

Any differences between the request or tender and the contract shall be resolved before any work commences. Each contract shall be acceptable both to the laboratory and the client.

A contract may be any written or oral agreement to provide a client with environmental testing services.

5.4.4.2 Records of reviews, including any significant changes, shall be maintained. Records shall also be maintained of pertinent discussions with a client relating to the client's requirements or the results of the work during the period of execution of the contract.

For review of routine and other simple tasks, the date and the identification (e. g. the initials) of the person in the laboratory responsible for carrying out the contracted work are considered adequate. For repetitive routine tasks, the review need be made only at the initial inquiry stage or on granting of the contract for on-going routine work performed under a general agreement with the client, provided that the client's requirements remain unchanged. For new, complex or advanced environmental testing tasks, a more comprehensive record should be maintained.

5.4.4.3 The review shall also cover any work that is subcontracted by the laboratory.

5.4.4.4 The client shall be informed of any deviation from the contract.

5.4.4.5 If a contract needs to be amended after work has commenced, the same contract review process shall be repeated and any amendments shall be communicated to all affected personnel. Suspension of accreditation, revocation of accreditation, or voluntary withdrawal of accreditation must be reported to the client.

5.4.5 Subcontracting of Environmental Tests

5.4.5.1 When a laboratory subcontracts work whether because of unforeseen reasons (e. g. workload, need for further expertise or temporary incapacity) or on a continuing basis (e. g. through permanent subcontracting, agency or franchising arrangements), this work shall be placed with a laboratory accredited under NELAP for the tests to be performed or with a laboratory that meets applicable statutory and regulatory requirements for performing the tests and submitting the results of tests performed. The laboratory performing the subcontracted work shall be indicated in the final report and non-NELAP accredited work shall be clearly identified.

5.4.5.2 The laboratory shall advise the client of the arrangement in writing and, when possible, gain the approval of the client, preferably in writing.

5.4.5.3 The laboratory is responsible to the client for the subcontractor's work, except in the case where the client or a regulatory authority specifies which subcontractor is to be used.

5.4.5.4 The laboratory shall maintain a register of all subcontractors that it uses for environmental tests and a record of the evidence of compliance with 5.4.5.1.

5.4.6 Purchasing Services and Supplies

5.4.6.1 The laboratory shall have a policy and procedure(s) for the selection and purchasing of services and supplies it uses that affect the quality of the environmental tests. Procedures shall exist for the purchase, reception and storage of reagents and laboratory consumable materials relevant for the environmental tests.

5.4.6.2 The laboratory shall ensure that purchased supplies and reagents and consumable materials that affect the quality of environmental tests are not used until they have been

inspected or otherwise verified as complying with standard specifications or requirements defined in the methods for the environmental tests concerned. These services and supplies used shall comply with specified requirements. Records of actions taken to check compliance shall be maintained.

5.4.6.3 Purchasing documents for items affecting the quality of laboratory output shall contain data describing the services and supplies ordered. These purchasing documents shall be reviewed and approved for technical content prior to release.

5.4.6.4 The laboratory shall evaluate suppliers of critical consumables, supplies and services which affect the quality of environmental testing, and shall maintain records of these evaluations and list those approved.

5.4.7 Service to the Client

The laboratory shall afford clients or their representatives cooperation to clarify the client's request and to monitor the laboratory's performance in relation to the work performed, provided that the laboratory ensures confidentiality to other clients.

5.4.8 Complaints

The laboratory shall have a policy and procedure for the resolution of complaints received from clients or other parties. Records shall be maintained of all complaints and of the investigations and corrective actions taken by the laboratory (see also 5.4.10).

5.4.9 Control of Nonconforming Environmental Testing Work

5.4.9.1 The laboratory shall have a policy and procedures that shall be implemented when any aspect of its environmental testing work, or the results of this work, do not conform to its own procedures or the agreed requirements of the client. The policy and procedures shall ensure that:

a) the responsibilities and authorities for the management of nonconforming work are designated and actions (including halting of work and withholding of test reports, as necessary) are defined and taken when nonconforming work is identified;

b) an evaluation of the significance of the nonconforming work is made;

c) corrective actions are taken immediately, together with any decision about the acceptability of the nonconforming work;

d) where the data quality is or may be impacted, the client is notified;

e) the responsibility for authorizing the resumption of work is defined.

5.4.9.2 Where the evaluation indicates that the nonconforming work could recur or that there is doubt about the compliance of the laboratory's operations with its own policies and procedures, the corrective action procedures given in 5.4.10 shall be promptly followed.

5.4.10 Corrective Action

5.4.10.1 General

The laboratory shall establish a policy and procedure and shall designate appropriate authorities for implementing corrective action when nonconforming work or departures from the policies and procedures in the quality system or technical operations have been identified.

5.4.10.2 Cause Analysis

The procedure for corrective action shall start with an investigation to determine the root cause(s) of the problem.

5.4.10.3 Selection and Implementation of Corrective Actions

Where corrective action is needed, the laboratory shall identify potential corrective actions. It shall select and implement the action(s) most likely to eliminate the problem and to prevent recurrence.

Corrective actions shall be to a degree appropriate to the magnitude and the risk of the problem.

The laboratory shall document and implement any required changes resulting from corrective action investigations.

5.4.10.4 Monitoring of Corrective Actions

The laboratory shall monitor the results to ensure that the corrective actions taken have been effective.

5.4.10.5 Additional Audits

Where the identification of nonconformances or departures casts doubts on the laboratory's compliance with its own policies and procedures, or on its compliance with this Standard, the laboratory shall ensure that the appropriate areas of activity are audited in accordance with 5.4.13 as soon as possible.

5.4.10.6 Technical Corrective Action

a) In addition to providing acceptance criteria and specific protocols for corrective actions in the Method SOPs (see 5.5.4.1.1), the laboratory shall implement general procedures to be followed to determine when departures from documented policies, procedures and quality control have occurred. These procedures shall include but are not limited to the following:

   1) identify the individual(s) responsible for assessing each QC data type;

   2) identify the individual(s) responsible for initiating and/or recommending corrective actions;

   3) define how the analyst shall treat a data set if the associated QC measurements are unacceptable;

4) specify how out-of-control situations and subsequent corrective actions are to be documented; and,

5) specify procedures for management (including the quality manager) to review corrective action reports.

b) To the extent possible, samples shall be reported only if all quality control measures are acceptable. If a quality control measure is found to be out of control, and the data is to be reported, all samples associated with the failed quality control measure shall be reported with the appropriate laboratory defined data qualifier(s).

5.4.11 Preventive Action

Preventive action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

5.4.11.1 Needed improvements and potential sources of nonconformances, either technical or concerning the quality system, shall be identified. If preventive action is required, action plans shall be developed, implemented and monitored to reduce the likelihood of the occurrence of such nonconformances and to take advantage of the opportunities for improvement.

5.4.11.2 Procedures for preventive actions shall include the initiation of such actions and application of controls to ensure that they are effective.

5.4.12 Control of Records

The laboratory shall maintain a record system to suit its particular circumstances and comply with any applicable regulations. The system shall produce unequivocal, accurate records which document all laboratory activities. The laboratory shall retain all original observations, calculations and derived data, calibration records and a copy of the test report for a minimum of five years.

There are two levels of sample handling: 1) sample tracking and 2) legal chain of custody protocols, which are used for evidentiary or legal purposes. All essential requirements for sample tracking (e. g., chain of custody form) are outlined in Sections 5.4.12.1.5, 5.4.12.2.4 and 5.4.12.2.5. If a client specifies that a sample will be used for evidentiary purposes, then a laboratory shall have a written SOP for how that laboratory will carry out legal chain of custody for example, ASTM D 4840- 95 and Manual for the Certification of Laboratories Analyzing Drinking Water, March 1997, Appendix A.

5.4.12.1 General

5.4.12.1.1 The laboratory shall establish and maintain procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records shall include reports from internal audits and management reviews as well as records of corrective and preventive actions. Records may be in any media, such as hard copy or electronic media.

5.4.12.1.2 All records shall be legible and shall be stored and retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss. Retention times of records shall be established.

5.4.12.1.3 All records shall be held secure and in confidence.

5.4.12.1.4 The laboratory shall have procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records.

5.4.12.1.5 The record keeping system must allow historical reconstruction of all laboratory activities that produced the analytical data. The history of the sample must be readily understood through the documentation. This shall include interlaboratory transfers of samples and/or extracts.

a) The records shall include the identity of personnel involved in sampling, sample receipt, preparation or testing.

b) All information relating to the laboratory facilities equipment, analytical test methods, and related laboratory activities, such as sample receipt, sample preparation, or data verification shall be documented.

c) The record keeping system shall facilitate the retrieval of all working files and archived records for inspection and verification purposes, e.g., set format for naming electronic files.

d) All changes to records shall be signed or initialed by responsible staff. The reason for the signature or initials shall be clearly indicated in the records such as "sampled by," "prepared by," or "reviewed by."

e) All generated data except those that are generated by automated data collection systems, shall be recorded directly, promptly and legibly in permanent ink.

f) Entries in records shall not be obliterated by methods such as erasures, overwritten files or markings. All corrections to record-keeping errors shall be made by one line marked through the error. The individual making the correction shall sign (or initial) and date the correction. These criteria also shall apply to electronically maintained records.

g) Refer to 5.5.4.7.2 for Computer and Electronic Data.

5.4.12.2 Technical Records

5.4.12.2.1 The laboratory shall retain records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each test report issued, for a defined period. The records for each environmental test shall contain sufficient information to facilitate identification of factors affecting the uncertainty and to enable the environmental test to be repeated under conditions as close as possible to the original. The records shall include the identity of personnel responsible for the sampling, performance of each environmental test and checking of results.

5.4.12.2.2 Observations, data and calculations shall be recorded at the time they are made and shall be identifiable to the specific task.

5.4.12.2.3 When mistakes occur in records, each mistake shall be crossed out, not erased, made illegible or deleted, and the correct value entered alongside. All such alterations to records shall

be signed or initialed by the person making the correction. In the case of records stored electronically, equivalent measures shall be taken to avoid loss or change of original data.

When corrections are due to reasons other than transcription errors, the reason for the correction shall be documented.

5.4.12.2.4 Records Management and Storage

a) All records (including those pertaining to test equipment), certificates and reports shall be safely stored, held secure and in confidence to the client. NELAP-related records shall be available to the accrediting authority.

b) All records, including those specified in 5.4.12.2.5 shall be retained for a minimum of five years from generation of the last entry in the records. All information necessary for the historical reconstruction of data must be maintained by the laboratory. Records which are stored only on electronic media must be supported by the hardware and software necessary for their retrieval.

c) Records that are stored or generated by computers or personal computers shall have hard copy or write-protected backup copies.

d) The laboratory shall establish a record management system for control of laboratory notebooks, instrument logbooks, standards logbooks, and records for data reduction, validation, storage and reporting.

e) Access to archived information shall be documented with an access log. These records shall be protected against fire, theft, loss, environmental deterioration, vermin and, in the case of electronic records, electronic or magnetic sources.

f) The laboratory shall have a plan to ensure that the records are maintained or transferred according to the clients' instructions (see 4.1.8.e) in the event that a laboratory transfers ownership or goes out of business. In addition, in cases of bankruptcy, appropriate regulatory and state legal requirements concerning laboratory records must be followed.

5.4.12.2.5 Laboratory Sample Tracking

5.4.12.2.5.1 Sample Handling

A record of all procedures to which a sample is subjected while in the possession of the laboratory shall be maintained. These shall include but are not limited to all records pertaining to:

a) sample preservation including appropriateness of sample container and compliance with holding time requirement;

b) sample identification, receipt, acceptance or rejection and log-in;

c) sample storage and tracking including shipping receipts, sample transmittal forms, (chain of custody form); and

d) documented procedures for the receipt and retention of samples, including all provisions necessary to protect the integrity of samples.

5.4.12.2.5.2 Laboratory Support Activities

In addition to documenting all the above-mentioned activities, the following shall be retained:

a) all original raw data, whether hard copy or electronic, for calibrations, samples and quality control measures, including analysts' work sheets and data output records (chromatograms, strip charts, and other instrument response readout records);

b) a written description or reference to the specific test method used which includes a description of the specific computational steps used to translate parametric observations into a reportable analytical value;

c) copies of final reports;

d) archived SOPs;

e) correspondence relating to laboratory activities for a specific project;

f) all corrective action reports, audits and audit responses;

g) proficiency test results and raw data; and,

h) results of data review, verification, and cross-checking procedures.

5.4.12.2.5.3 Analytical Records

The essential information to be associated with analysis, such as strip charts, tabular printouts, computer data files, analytical notebooks, and run logs, shall include:

a) laboratory sample ID code;

b) date of analysis and time of analysis is required if the holding time is 72 hours or less or when time critical steps are included in the analysis, e.g., extractions, and incubations;

c) instrumentation identification and instrument operating conditions/parameters (or reference to such data);

d) analysis type;

e) all manual calculations, e.g., manual integrations; and,

f) analyst's or operator's initials/signature;

g) sample preparation including cleanup, separation protocols, incubation periods or subculture, ID codes, volumes, weights, instrument printouts, meter readings, calculations, reagents;

h) sample analysis;

i) standard and reagent origin, receipt, preparation, and use;

j) calibration criteria, frequency and acceptance criteria;

k) data and statistical calculations, review, confirmation, interpretation, assessment and reporting conventions;

l) quality control protocols and assessment;

m) electronic data security, software documentation and verification, software and hardware audits, backups, and records of any changes to automated data entries;

n) method performance criteria including expected quality control requirements.

5.4.12.2.5.4 Administrative Records

The following shall be maintained:

a) personnel qualifications, experience and training records;

b) records of demonstration of capability for each analyst; and

c) a log of names, initials and signatures for all individuals who are responsible for signing or initialing any laboratory record.

5.4.13 Internal Audits

5.4.13.1 The laboratory shall periodically, in accordance with a predetermined schedule and procedure, and at least annually, conduct internal audits of its activities to verify that its operations continue to comply with the requirements of the quality system and this Standard. The internal audit program shall address all elements of the quality system, including the environmental testing activities. It is the responsibility of the quality manager to plan and organize audits as required by the schedule and requested by management. Such audits shall be carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited. Personnel shall not audit their own activities except when it can be demonstrated that an effective audit will be carried out.

5.4.13.2 When audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's environmental test results, the laboratory shall take timely corrective action, and shall notify clients in writing if investigations show that the laboratory results may have been affected.

The laboratory shall notify clients promptly, in writing, of any event such as the identification of defective measuring or test equipment that casts doubt on the validity of results given in any test report or test certificate or amendment to a report or certificate.

The laboratory must specify, in the laboratory's quality manual, the time frame for notifying a client of events that cast doubt on the validity results.

5.4.13.3 The area of activity audited, the audit findings and corrective actions that arise from them shall be recorded. The laboratory management shall ensure that these actions are discharged within the agreed time frame as indicated in the quality manual and/or SOPs.

5.4.13.4 Follow-up audit activities shall verify and record the implementation and effectiveness of the corrective action taken.

5.4.14 Management Reviews

5.4.14.1 In accordance with a predetermined schedule and procedure, the laboratory's executive management shall periodically and at least annually conduct a review of the laboratory's quality system and environmental testing activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review shall take account of:

a) the suitability of policies and procedures;

b) reports from managerial and supervisory personnel;

c) the outcome of recent internal audits;

d) corrective and preventive actions;

e) assessments by external bodies;

f) the results of interlaboratory comparisons or proficiency tests;

g) changes in the volume and type of the work;

h) client feedback;

i) complaints;

j) other relevant factors, such as quality control activities, resources and staff training.

5.4.14.2 Findings from management reviews and the actions that arise from them shall be recorded. The management shall ensure that those actions are carried out within an appropriate and agreed timescale.

The laboratory shall have a procedure for review by management and maintain records of review findings and actions.

5.4.15 The laboratory, as part of their overall internal auditing program, shall insure that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery of potential issues shall be handled in a confidential manner until such time as a follow up evaluation, full investigation, or other appropriate actions have been completed and the issues clarified. All investigations that result in finding of inappropriate activity shall be documented and shall include any disciplinary actions involved, corrective actions taken, and all appropriate notifications of clients. All documentation of these investigation and actions taken shall be maintained for at least five years.

5.5 TECHNICAL REQUIREMENTS

5.5.1 General

5.5.1.1 Many factors determine the correctness and reliability of the environmental tests performed by a laboratory. These factors include contributions from:

a) human factors (5.5.2);

b) accommodation and environmental conditions (5.5.3);

c) environmental test methods and method validation (5.5.4);

d) equipment (5.5.5);

e) measurement traceability (5.5.6);

f) sampling (5.5.7);

g) the handling of samples (5.5.8).

5.5.1.2 The extent to which the factors contribute to the total uncertainty of measurement differs considerably between (types of) environmental tests. The laboratory shall take account of these factors in developing environmental test methods and procedures, in the training and qualification of personnel, and in the selection and calibration of the equipment it uses.

5.5.2 Personnel

5.5.2.1 The laboratory management shall ensure the competence of all who operate specific equipment, perform environmental tests, evaluate results, and sign test reports. When using staff who are undergoing training, appropriate supervision shall be provided. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required.

The laboratory shall have sufficient personnel with the necessary education, training, technical knowledge and experience for their assigned functions.

All personnel shall be responsible for complying with all quality assurance/quality control requirements that pertain to their organizational/technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate a specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures and records management.

5.5.2.2 The management of the laboratory shall formulate the goals with respect to the education, training and skills of the laboratory personnel. The laboratory shall have a policy and procedures for identifying training needs and providing training of personnel. The training program shall be relevant to the present and anticipated tasks of the laboratory.

5.5.2.3 The laboratory shall use personnel who are employed by, or under contract to, the laboratory. Where contracted and additional technical and key support personnel are used, the

laboratory shall ensure that such personnel are supervised and competent and that they work in accordance with the laboratory's quality system.

5.5.2.4 The laboratory shall maintain current job descriptions for all personnel who manage, perform, or verify work affecting the quality of the environmental tests.

5.5.2.5 The management shall authorize specific personnel to perform particular types of sampling, environmental testing, to issue test reports, to give opinions and interpretations and to operate particular types of equipment. The laboratory shall maintain records of the relevant authorization(s), competence, educational and professional qualifications, training, skills and experience of all technical personnel, including contracted personnel. This information shall be readily available and shall include the date on which authorization and/or competence is confirmed.

Records on the relevant qualifications, training, skills and experience of the technical personnel shall be maintained by the laboratory [see 5.5.2.6.c], including records on demonstrated proficiency for each laboratory test method, such as the criteria outlined in 5.5.4.2.2 for chemical testing.

5.5.2.6 The laboratory management shall be responsible for:

a) defining the minimal level of qualification, experience and skills necessary for all positions in the laboratory. In addition to education and/or experience, basic laboratory skills such as using a balance, colony counting, aseptic or quantitative techniques shall be considered;

b) ensuring that all technical laboratory staff have demonstrated capability in the activities for which they are responsible. Such demonstration shall be documented. (See Appendix C);

Note: In laboratories with specialized "work cells" (a well defined group of analysts that together perform the method analysis), the group as a unit must meet the above criteria and this demonstration must be fully documented.

c) ensuring that the training of each member of the technical staff is kept up-to-date (on-going) by the following:

   1) Evidence must be on file that demonstrates that each employee has read, understood, and is using the latest version of the laboratory's in-house quality documentation, which relates to his/her job responsibilities.

   2) Training courses or workshops on specific equipment, analytical techniques or laboratory procedures shall all be documented.

   3) Analyst training shall be considered up to date if an employee training file contains a certification that technical personnel have read, understood and agreed to perform the most recent version of the test method (the approved method or standard operating procedure as defined by the laboratory document control system, 5.4.2.3.d) and documentation of continued proficiency by at least one of the following once per year:

      i. acceptable performance of a blind sample (single blind to the analyst). Note:

successful analysis of a blind performance sample on a similar test method using the same technology (e.g., GC/MS volatiles by purge and trap for Methods 524.2, 624 or 5030/8260) would only require documentation for one of the test methods. The laboratory must determine the acceptable limits of the blind performance sample prior to analysis;

ii. an initial measurement system evaluation or another demonstration of capability;

iii. at least four consecutive laboratory control samples with acceptable levels of precision and accuracy. The laboratory must determine the acceptable limits for precision and accuracy prior to analysis; or

iv. if i-iii cannot be performed, analysis of authentic samples with results statistically indistinguishable from those obtained by another trained analyst.

d) documenting all analytical and operational activities of the laboratory;

e) supervising all personnel employed by the laboratory.

f) ensuring that all sample acceptance criteria (Section 5.5.8) are verified and that samples are logged into the sample tracking system and properly labeled and stored;

g) documenting the quality of all data reported by the laboratory; and

5.5.2.7 Data integrity training shall be provided as a formal part of new employee orientation and must also be provided on an annual basis for all current employees. Topics covered shall be documented in writing and provided to all trainees. Key topics covered during training must include organizational mission and its relationship to the critical need for honesty and full disclosure in all analytical reporting, how and when to report data integrity issues, and record keeping. Training shall include discussion regarding all data integrity procedures, data integrity training documentation, in-depth data monitoring and data integrity procedure documentation. Employees are required to understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious consequences including immediate termination, debarment or civil/criminal prosecution. The initial data integrity training and the annual refresher training shall have a signature attendance sheet or other form of documentation that demonstrates all staff have participated and understand their obligations related to data integrity. Senior managers acknowledge their support of these procedures by 1) upholding the spirit and intent of the organization's data integrity procedures and 2) effectively implementing the specific requirements of the procedures.

Specific examples of breaches of ethical behavior should be discussed including improper data manipulations, adjustments of instrument time clocks, and inappropriate changes in concentrations of standards. Data integrity training requires emphasis on the importance of proper written narration on the part of the analyst with respect to those cases where analytical data may be useful, but are in one sense or another partially deficient. The data integrity procedures may also include written ethics agreements, examples of improper practices, examples of improper chromatographic manipulations, requirements for external ethics program training, and any external resources available to employees.

5.5.3 Accommodation and Environmental Conditions

5.5.3.1 Laboratory facilities for environmental testing, including but not limited to energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of the environmental tests.

The laboratory shall ensure that the environmental conditions do not invalidate the results or adversely affect the required quality of any measurement. Particular care shall be taken when sampling and environmental tests are undertaken at sites other than a permanent laboratory facility. The technical requirements for accommodation and environmental conditions that can affect the results of environmental tests shall be documented.

5.5.3.2 The laboratory shall monitor, control and record environmental conditions as required by the relevant specifications, methods and procedures or where they influence the quality of the results. Due attention shall be paid, for example, to biological sterility, dust, electromagnetic disturbances, radiation, humidity, electrical supply, temperature, and sound and vibration levels, as appropriate to the technical activities concerned. Environmental tests shall be stopped when the environmental conditions jeopardize the results of the environmental tests.

In instances where monitoring or control of any of the above mentioned items are specified in a test method or by regulation, the laboratory shall meet and document adherence to the laboratory facility requirements.

5.5.3.3 There shall be effective separation between neighboring areas in which there are incompatible activities including culture handling or incubation areas and volatile organic chemicals handling areas. Measures shall be taken to prevent cross-contamination.

5.5.3.4 Access to and use of areas affecting the quality of the environmental tests shall be controlled. The laboratory shall determine the extent of control based on its particular circumstances.

5.5.3.5 Measures shall be taken to ensure good housekeeping in the laboratory. Special procedures shall be prepared where necessary.

5.5.3.6 Work spaces must be available to ensure an unencumbered work area. Work areas include:

a) access and entryways to the laboratory;

b) sample receipt area(s);

c) sample storage area(s);

d) chemical and waste storage area(s); and,

e) data handling and storage area(s).

5.5.4 Environmental Test Methods and Method Validation

5.5.4.1 General

The laboratory shall use appropriate methods and procedures for all environmental tests within its scope. These include sampling, handling, transport, storage and preparation of samples, and, where appropriate, an estimation of the measurement uncertainty as well as statistical techniques for analysis of environmental test data.

The laboratory shall have instructions on the use and operation of all relevant equipment, and on the handling and preparation of samples where the absence of such instructions could jeopardize the results of environmental tests. All instructions, standards, manuals and reference data relevant to the work of the laboratory shall be kept up to date and shall be made readily available to personnel (see 5.4.3). Deviation from environmental test methods shall occur only if the deviation has been documented, technically justified, authorized, and accepted by the client.

5.5.4.1.1 Standard Operating Procedures (SOPs)

Laboratories shall maintain SOPs that accurately reflect all phases of current laboratory activities such as assessing data integrity, corrective actions, handling customer complaints, and all test methods.

a) These documents, for example, may be equipment manuals provided by the manufacturer, or internally written documents with adequate detail to allow someone similarly qualified, other than the analyst, to reproduce the procedures used to generate the test result.

b) The test methods may be copies of published methods as long as any changes or selected options in the methods are documented and included in the methods manual (see 5.5.4.1.2).

c) Copies of all SOPs shall be accessible to all personnel.

d) The SOPs shall be organized.

e) Each SOP shall clearly indicate the effective date of the document, the revision number and the signature(s) of the approving authority.

f) The documents specified in 5.5.4.1.1 a) and 5.5.4.1.1 b) that contain sufficient information to perform the tests do not need to be supplemented or rewritten as internal procedures, if the documents are written in a way that they can be used as written. Any changes, including the use of a selected option must be documented and included in the laboratory's methods manual.

5.5.4.1.2 Laboratory Method Manual(s)

a) The laboratory shall have and maintain an in-house methods manual(s) for each accredited analyte or test method.

b) This manual may consist of copies of published or referenced test methods or SOPs that have been written by the laboratory. In cases where modifications to the published

method have been made by the laboratory or where the referenced test method is ambiguous or provides insufficient detail, these changes or clarifications shall be clearly described. Each test method shall include or reference where applicable:

1) identification of the test method;
2) applicable matrix or matrices;
3) detection limit;
4) scope and application, including components to be analyzed;
5) summary of the test method;
6) definitions;
7) interferences;
8) safety;
9) equipment and supplies;
10) reagents and standards;
11) sample collection, preservation, shipment and storage;
12) quality control;
13) calibration and standardization;
14) procedure;
15) data analysis and calculations;
16) method performance;
17) pollution prevention;
18) data assessment and acceptance criteria for quality control measures;
19) corrective actions for out-of-control data;
20) contingencies for handling out-of-control or unacceptable data;
21) waste management;
22) references; and,
23) any tables, diagrams, flowcharts and validation data.

5.5.4.2 Selection of Methods

The laboratory shall use methods for environmental testing, including methods for sampling, which meet the needs of the client and which are appropriate for the environmental tests it undertakes.

5.5.4.2.1 Sources of Methods

a) Methods published in international, regional or national standards shall preferably be used. The laboratory shall ensure that it uses the latest valid edition of a standard unless it is not appropriate or possible to do so. When necessary, the standard shall be supplemented with additional details to ensure consistent application.

b) When the use of specific methods for a sample analysis are mandated or requested, only those methods shall be used.

c) When the client does not specify the method to be used or where methods are employed that are not required, the methods shall be fully documented and validated (see 5.5.4.2.2, 5.5.4.5, and Appendix C), and be available to the client and other recipients of the relevant reports. The laboratory shall select appropriate methods that have been published either in international, regional or national standards, or by reputable technical organizations, or in relevant scientific texts or journals, or as specified by the manufacturer of the equipment. Laboratory-developed methods or methods adopted by

the laboratory may also be used if they are appropriate for the intended use and if they are validated. The client shall be informed as to the method chosen.

d) The laboratory shall inform the client when the method proposed by the client is considered to be inappropriate or out of date.

5.5.4.2.2 Demonstration of Capability

The laboratory shall confirm that it can properly operate all methods before introducing the environmental tests. If the method changes, the confirmation shall be repeated.

a) Prior to acceptance and institution of any method, satisfactory demonstration of method capability is required. (See Appendix C and 5.5.2.6.b) In general, this demonstration does not test the performance of the method in real world samples, but in the applicable and available clean quality system matrix sample (a quality system matrix in which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., drinking water, solids, biological tissue and air. In addition, for analytes which do not lend themselves to spiking, the demonstration of capability may be performed using quality control samples.

b) Thereafter, continuing demonstration of method performance, as per the quality control requirements in Appendix D (such as laboratory control samples) is required.

c) In cases where a laboratory analyzes samples using a method that has been in use by the laboratory before July 1999, and there have been no significant changes in instrument type, personnel or method, the continuing demonstration of method performance and the analyst's documentation of continued proficiency shall be acceptable. The laboratory shall have records on file to demonstrate that a demonstration of capability is not required.

d) In all cases, the appropriate forms such as the Certification Statement (Appendix C) must be completed and retained by the laboratory to be made available upon request. All associated supporting data necessary to reproduce the analytical results summarized in the Certification Statement must be retained by the laboratory. (See Appendix C for Certification Statement.)

e) A demonstration of capability must be completed each time there is a change in instrument type, personnel, or method.

f) In laboratories with a specialized "work cell(s)" (a group consisting of analysts with specifically defined tasks that together perform the test method), the group as a unit must meet the above criteria and this demonstration of capability must be fully documented.

g) When a work cell(s) is employed, and the members of the cell change, the new employee(s) must work with experienced analyst(s) in that area of the work cell where they are employed. This new work cell must demonstrate acceptable performance through acceptable continuing performance checks (appropriate sections of Appendix D, such as laboratory control samples). Such performance must be documented and the four preparation batches following the change in personnel must not result in the failure of any batch acceptance criteria, e.g., method blank and laboratory control sample, or the demonstration of capability must be repeated. In addition, if the entire work cell is

changed/replaced, the work cell must perform the demonstration of capability (Appendix C).

h) When a work cell(s) is employed the performance of the group must be linked to the training record of the individual members of the work cell (see section 5.5.2.6).

5.5.4.3 Laboratory-Developed Methods

The introduction of environmental test methods developed by the laboratory for its own use shall be a planned activity and shall be assigned to qualified personnel equipped with adequate resources.

Plans shall be updated as development proceeds and effective communication amongst all personnel involved shall be ensured.

5.5.4.4 Non-Standard Methods

When it is necessary to use methods not covered by standard methods, these shall be subject to agreement with the client and shall include a clear specification of the client's requirements and the purpose of the environmental test. The method developed shall have been validated appropriately before use.

5.5.4.5 Validation of Methods

5.5.4.5.1 Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

5.5.4.5.2 The laboratory shall validate non-standard methods, laboratory-designed/developed methods, standard methods used outside their published scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use. The validation shall be as extensive as is necessary to meet the needs of the given application or field of application. The laboratory shall record the results obtained, the procedure used for the validation, and a statement as to whether the method is fit for the intended use. The minimum requirements shall be the initial test method evaluation requirements given in Appendix C.3 of this chapter.

5.5.4.5.3 The range and accuracy of the values obtainable from validated methods (e. g. the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object), as assessed for the intended use, shall be relevant to the clients' needs.

5.5.4.6 Estimation of Uncertainty of Measurement

5.5.4.6.1 Environmental testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement. In certain cases the nature of the test method may preclude rigorous, metrologically and statistically valid, calculation of uncertainty of measurement. In these cases the laboratory shall at least attempt to identify all the components of uncertainty and make a reasonable estimation, and shall ensure that the form of reporting of the result does not give a wrong impression of the uncertainty. Reasonable estimation shall be based on knowledge of the

performance of the method and on the measurement scope and shall make use of, for example, previous experience and validation data.

In those cases where a well-recognized test method specifies limits to the values of the major sources of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied this clause by following the test method and reporting instructions (see 5.5.10).

5.5.4.6.2 When estimating the uncertainty of measurement, all uncertainty components which are of importance in the given situation shall be taken into account using appropriate methods of analysis.

5.5.4.7 Control of Data

5.5.4.7.1 Calculations and data transfers shall be subject to appropriate checks in a systematic manner.

a) The laboratory shall establish SOPs to ensure that the reported data are free from transcription and calculation errors.

b) The laboratory shall establish SOPs to ensure that all quality control measures are reviewed, and evaluated before data are reported.

c) The laboratory shall establish SOPs addressing manual calculations including manual integrations.

5.5.4.7.2 When computers, automated equipment, or microprocessors are used for the acquisition, processing, recording, reporting, storage or retrieval of environmental test data, the laboratory shall ensure that:

a) computer software developed by the user is documented in sufficient detail and is suitably validated as being adequate for use;

b) procedures are established and implemented for protecting the data; such procedures shall include, but not be limited to, integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;

c) computers and automated equipment are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of environmental test data.

d) it establishes and implements appropriate procedures for the maintenance of security of data including the prevention of unauthorized access to, and the unauthorized amendment of, computer records.

Commercial off-the-shelf software (e. g. word processing, database and statistical programs) in general use within their designed application range is considered to be sufficiently validated. However, laboratory software configuration or modifications must be validated as in 5.5.4.7.2a.

5.5.5 Equipment

5.5.5.1 The laboratory shall be furnished with all items of sampling, measurement and test equipment required for the correct performance of the environmental tests (including sampling, preparation of samples, processing and analysis of environmental data). In those cases where the laboratory needs to use equipment outside its permanent control, it shall ensure that the requirements of this Standard are met.

5.5.5.2 Equipment and its software used for testing and sampling shall be capable of achieving the accuracy required and shall comply with specifications relevant to the environmental tests concerned. Before being placed into service, equipment (including that used for sampling) shall be calibrated or checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications.

Calibration requirements are divided into two parts: (1) requirements for analytical support equipment, and 2) requirements for instrument calibration. In addition, the requirements for instrument calibration are divided into initial instrument calibration and continuing instrument calibration verification.

5.5.5.2.1 Support Equipment

These standards apply to all devices that may not be the actual test instrument, but are necessary to support laboratory operations. These include but are not limited to: balances, ovens, refrigerators, freezers, incubators, water baths, temperature measuring devices (including thermometers and thermistors), thermal/pressure sample preparation devices and volumetric dispensing devices (such as Eppendorf®, or automatic dilutor/dispensing devices) if quantitative results are dependent on their accuracy, as in standard preparation and dispensing or dilution into a specified volume.

a) All support equipment shall be maintained in proper working order. The records of all repair and maintenance activities including service calls, shall be kept.

b) All support equipment shall be calibrated or verified at least annually, using NIST traceable references when available, over the entire range of use. The results of such calibration or verification shall be within the specifications required of the application for which this equipment is used or:

   1) the equipment shall be removed from service until repaired; or

   2) the laboratory shall maintain records of established correction factors to correct all measurements.

c) Raw data records shall be retained to document equipment performance.

d) Prior to use on each working day, balances, ovens, refrigerators, freezers, and water baths shall be checked in the expected use range, with NIST traceable references where commercially available. The acceptability for use or continued use shall be according to the needs of the analysis or application for which the equipment is being used.

e) Mechanical volumetric dispensing devices including burettes (except Class A glassware) shall be checked for accuracy on at least a quarterly use basis. Glass microliter syringes

are to be considered in the same manner as Class A glassware, but must come with a certificate attesting to established accuracy or the accuracy must be initially demonstrated and documented by the laboratory.

f) For chemical tests the temperature, cycle time, and pressure of each run of autoclaves must be documented by the use of appropriate chemical indicators or temperature recorders and pressure gauges.

g) For biological tests that employ autoclave sterilization see section D.3.8.

5.5.5.2.2 Instrument Calibration

This standard specifies the essential elements that shall define the procedures and documentation for initial instrument calibration and continuing instrument calibration verification to ensure that the data must be of known quality and be appropriate for a given regulation or decision. This standard does not specify detailed procedural steps ("how to") for calibration, but establishes the essential elements for selection of the appropriate technique(s). This approach allows flexibility and permits the employment of a wide variety of analytical procedures and statistical approaches currently applicable for calibration. If more stringent standards or requirements are included in a mandated test method or by regulation, the laboratory shall demonstrate that such requirements are met. If it is not apparent which standard is more stringent, then the requirements of the regulation or mandated test method are to be followed.

5.5.5.2.2.1 Initial Instrument Calibration

The following items are essential elements of initial instrument calibration:

a) The details of the initial instrument calibration procedures including calculations, integrations, acceptance criteria and associated statistics must be included or referenced in the test method SOP. When initial instrument calibration procedures are referenced in the test method, then the referenced material must be retained by the laboratory and be available for review.

b) Sufficient raw data records must be retained to permit reconstruction of the initial instrument calibration, e.g., calibration date, test method, instrument, analysis date, each analyte name, analyst's initials or signature; concentration and response, calibration curve or response factor; or unique equation or coefficient used to reduce instrument responses to concentration.

c) Sample results must be quantitated from the initial instrument calibration and may not be quantitated from any continuing instrument calibration verification unless otherwise required by regulation, method, or program.

d) All initial instrument calibrations must be verified with a standard obtained from a second manufacturer or lot if the lot can be demonstrated from the manufacturer as prepared independently from other lots. Traceability shall be to a national standard, when commercially available.

e) Criteria for the acceptance of an initial instrument calibration must be established, e.g., correlation coefficient or relative percent difference. The criteria used must be appropriate to the calibration technique employed.

f) The lowest calibration standard shall be the lowest concentration for which quantitative data are to be reported (see Appendix C). Any data reported below the lower limit of quantitation should be considered to have an increased quantitative uncertainty and shall be reported using defined qualifiers or flags or explained in the case narrative.

g) The highest calibration standard shall be the highest concentration for which quantitative data are to be reported (see Appendix C.) Any data reported above this highest standard should be considered to have an increased quantitative uncertainty and shall be reported using defined qualifiers or flags or explained in the case narrative.

h) Measured concentrations outside the working range shall be reported as having less certainty and shall be reported using defined qualifiers or flags or explained in the case narrative. The lowest calibration standard must be above the limit of detection. Noted exception: The following shall occur for instrument technology (such as ICP or ICP/MS) with validated techniques from manufacturers or methods employing standardization with a zero point and a single point calibration standard:

1) Prior to the analysis of samples the zero point and single point calibration must be analyzed and the linear range of the instrument must be established by analyzing a series of standards, one of which must be at the lowest quantitation level. Sample results within the established linear range will not require data qualifier flags.

2) Zero point and single point calibration standard must be analyzed with each analytical batch.

3) A standard corresponding to the limit of quantitation must be analyzed with each analytical batch and must meet established acceptance criteria.

4) The linearity is verified at a frequency established by the method and/or the manufacturer.

i) If the initial instrument calibration results are outside established acceptance criteria, corrective actions must be performed and all associated samples reanalyzed. If reanalysis of the samples is not possible, data associated with an unacceptable initial instrument calibration shall be reported with appropriate data qualifiers.

j) If a reference or mandated method does not specify the number of calibration standards, the minimum number is two, (one of which must be at the limit of quantitation) not including blanks or a zero standard with the noted exception of instrument technology for which it has been established by methodologies and procedures that a zero and a single point standard are appropriate for calibrations (see 5.5.5.2.2.1 h). The laboratory must have a standard operating procedure for determining the number of points for establishing the initial instrument calibration.

5.5.5.3 Equipment shall be operated by authorized personnel. Up-to-date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) shall be readily available for use by the appropriate laboratory personnel.

All equipment shall be properly maintained, inspected and cleaned. Maintenance procedures shall be documented.

5.5.5.4 Each item of equipment and its software used for environmental testing and significant to the result shall, when practicable, be uniquely identified.

5.5.5.5 The laboratory shall maintain records of each major item of equipment and its software significant to the environmental tests performed. The records shall include at least the following:

a) the identity of the item of equipment and its software;

b) the manufacturer's name, type identification, and serial number or other unique identification;

c) checks that equipment complies with the specification (see 5.5.5.2);

d) the current location;

e) the manufacturer's instructions, if available, or reference to their location;

f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

g) the maintenance plan, where appropriate, and maintenance carried out to date; documentation on all routine and non-routine maintenance activities and reference material verifications.

h) any damage, malfunction, modification or repair to the equipment.

i) date received and date placed in service (if available);

j) if available, condition when received (e.g. new, used, reconditioned);

5.5.5.6 The laboratory shall have procedures for safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and in order to prevent contamination or deterioration.

5.5.5.7 Equipment that has been subjected to overloading or mishandling, gives suspect results, or has been shown to be defective or outside specified limits, shall be taken out of service. It shall be isolated to prevent its use or clearly labeled or marked as being out of service, until it has been repaired and shown by calibration or test to perform correctly. The laboratory shall examine the effect of the defect or departure from specified limits on previous environmental tests and shall institute the "Control of nonconforming work" procedure (see 5.4.9).

5.5.5.8 Whenever practicable, all equipment under the control of the laboratory and requiring calibration shall be labeled, coded or otherwise identified to indicate the status of calibration, including the date when last calibrated and the date or expiration criteria when recalibration is due.

5.5.5.9 When, for whatever reason, equipment goes outside the direct control of the laboratory, the laboratory shall ensure that the function and calibration status of the equipment are checked and shown to be satisfactory before the equipment is returned to service.

5.5.5.10 When an initial instrument calibration is not performed on the day of analysis, the validity of the initial calibration shall be verified prior to sample analyses by continuing instrument calibration verification with each analytical batch. The following items are essential elements of continuing instrument calibration verification:

a) The details of the continuing instrument calibration procedure, calculations and associated statistics must be included or referenced in the test method SOP.

b) Calibration shall be verified for each compound, element, or other discrete chemical species, except for multi-component analytes such as Aroclors, Total Petroleum Hydrocarbons, or Toxaphene where a representative chemical related substance or mixture can be used.

c) Instrument calibration verification must be performed:

   1) at the beginning and end of each analytical batch (except, if an internal standard is used, only one verification needs to be performed at the beginning of the analytical batch);

   2) whenever it is expected that the analytical system may be out of calibration or might not meet the verification acceptance criteria;

   3) if the time period for calibration or the most previous calibration verification has expired; or

   4) for analytical systems that contain a calibration verification requirement.

d) Sufficient raw data records must be retained to permit reconstruction of the continuing instrument calibration verification, e.g., test method, instrument, analysis date, each analyte name, concentration and response, calibration curve or response factor, or unique equations or coefficients used to convert instrument responses into concentrations. Continuing calibration verification records must explicitly connect the continuing verification data to the initial instrument calibration.

e) Criteria for the acceptance of a continuing instrument calibration verification must be established, e.g., relative percent difference.

   If the continuing instrument calibration verification results obtained are outside established acceptance criteria, corrective actions must be performed. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then either the laboratory has to demonstrate acceptable performance after corrective action with two consecutive calibration verifications, or a new initial instrument calibration must be performed. If the laboratory has not verified calibration, sample analyses may not occur until the analytical system is calibrated or calibration verified. If samples are analyzed using a system on which the calibration has not yet been verified the results shall be flagged. Data associated with an

unacceptable calibration verification may be fully useable under the following special conditions:

1) when the acceptance criteria for the continuing calibration verification are exceeded high, i.e., high bias, and there are associated samples that are non-detects, then those non-detects may be reported. Otherwise the samples affected by the unacceptable calibration verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

2) when the acceptance criteria for the continuing calibration verification are exceeded low, i.e., low bias, those sample results may be reported if they exceed a maximum regulatory limit/decision level. Otherwise the samples affected by the unacceptable verification shall be reanalyzed after a new calibration curve has been established, evaluated and accepted.

5.5.5.11 Where calibrations give rise to a set of correction factors, the laboratory shall have procedures to ensure that copies (e. g. in computer software) are correctly updated.

5.5.5.12 Test equipment, including both hardware and software, shall be safeguarded from adjustments which would invalidate the test results.

5.5.6 Measurement Traceability

5.5.6.1 General

All equipment used for environmental tests, including equipment for subsidiary measurements (e. g. for environmental conditions) having a significant effect on the accuracy or validity of the result of the environmental test or sampling shall be calibrated before being put into service and on a continuing basis. The laboratory shall have an established program and procedure for the calibration of its equipment. This includes balances, thermometers, and control standards. Such a program shall include a system for selecting, using, calibrating, checking, controlling and maintaining measurement standards, reference materials used as measurement standards, and measuring and test equipment used to perform environmental tests.

5.5.6.2 Testing Laboratories

5.5.6.2.1 For testing laboratories, the laboratory shall ensure that the equipment used can provide the uncertainty of measurement needed.

a) The overall program of calibration and/or verification and validation of equipment shall be designed and operated so as to ensure that measurements made by the laboratory are traceable to national standards of measurement.

5.5.6.2.2 Where traceability of measurements to SI units is not possible or not relevant, the same requirements for traceability to, for example, certified reference materials, agreed methods and/or consensus standards, are required. The laboratory shall provide satisfactory evidence of correlation of results, for example by participation in a suitable program of interlaboratory comparisons, proficiency testing, or independent analysis.

5.5.6.3 Reference Standards and Reference Materials

5.5.6.3.1 Reference Standards

The laboratory shall have a program and procedure for the calibration of its reference standards. Reference standards shall be calibrated by a body that can provide traceability as described in 5.5.6.2.1. Such reference standards of measurement held by the laboratory (such as class S or equivalent weights or traceable thermometers) shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated. Reference standards shall be calibrated before and after any adjustment. Where commercially available, this traceability shall be to a national standard of measurement.

5.5.6.3.2 Reference Materials

Reference materials shall, where commercially available, be traceable to SI units of measurement, or to certified reference materials. Where possible, traceability shall be to national or international standards of measurement, or to national or international standard reference materials. Internal reference materials shall be checked as far as is technically and economically practicable.

5.5.6.3.3 Intermediate Checks

Checks needed to maintain confidence in the status of reference, primary, transfer or working standards and reference materials shall be carried out according to defined procedures and schedules.

5.5.6.3.4 Transport and Storage

The laboratory shall have procedures for safe handling, transport, storage and use of reference standards and reference materials in order to prevent contamination or deterioration and in order to protect their integrity.

5.5.6.4 Documentation and Labeling of Standards, Reagents, and Reference Materials

Documented procedures shall exist for the purchase, reception and storage of consumable materials used for the technical operations of the laboratory.

a) The laboratory shall retain records for all standards, reagents, reference materials and media including the manufacturer/vendor, the manufacturer's Certificate of Analysis or purity (if supplied), the date of receipt, recommended storage conditions, and an expiration date after which the material shall not be used unless its reliability is verified by the laboratory.

b) Original containers (such as provided by the manufacturer or vendor) shall be labeled with an expiration date.

c) Records shall be maintained on standard and reference material preparation. These records shall indicate traceability to purchased stocks or neat compounds, reference to the method of preparation, date of preparation, expiration date and preparer's initials.

d) All containers of prepared, standards, and reference materials must bear a unique identifier and expiration date and be linked to the documentation requirements in 5.5.6.4.c above.

e) Procedures shall be in place to ensure prepared reagents meet the requirements of the test method. The source of reagents shall comply with 5.5.9.2 a) 6) and D.1.4 b).

f) All containers of prepared reagents must bear a preparation date. An expiration date shall be defined on the container or documented elsewhere as indicated in the laboratory's quality manual or SOP.

5.5.7 Sampling

5.5.7.1 The laboratory shall have a sampling plan and procedures for sampling when it carries out sampling of substances, materials or products for subsequent environmental testing. The sampling plan as well as the sampling procedure shall be available at the location where sampling is undertaken. Sampling plans shall, whenever reasonable, be based on appropriate statistical methods. The sampling process shall address the factors to be controlled to ensure the validity of the environmental test results.

Where sampling (as in obtaining sample aliquots from a submitted sample) is carried out as part of the test method, the laboratory shall use documented procedures and appropriate techniques to obtain representative subsamples.

5.5.7.2 Where the client requires deviations, additions or exclusions from the documented sampling procedure, these shall be recorded in detail with the appropriate sampling data and shall be included in all documents containing environmental test and/or calibration results, and shall be communicated to the appropriate personnel.

5.5.7.3 The laboratory shall have procedures for recording relevant data and operations relating to sampling that forms part of the environmental testing that is undertaken. These records shall include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant) and diagrams or other equivalent means to identify the sampling location as necessary and, if appropriate, the statistics the sampling procedures are based upon.

5.5.8 Handling of Samples

While the laboratory may not have control of field sampling activities, the following are essential to ensure the validity of the laboratory's data.

5.5.8.1 The laboratory shall have procedures for the transportation, receipt, handling, protection, storage, retention and/or disposal of samples, including all provisions necessary to protect the integrity of the sample, and to protect the interests of the laboratory and the client.

5.5.8.2 The laboratory shall have a system for identifying samples. The identification shall be retained throughout the life of the sample in the laboratory. The system shall be designed and operated so as to ensure that samples cannot be confused physically or when referred to in records or other documents. The system shall, if appropriate, accommodate a sub-division of groups of samples and the transfer of samples within and from the laboratory.

a) The laboratory shall have a documented system for uniquely identifying the samples to be tested, to ensure that there can be no confusion regarding the identity of such samples at any time. This system shall include identification for all samples, subsamples and subsequent extracts and/or digestates. The laboratory shall assign a unique identification (ID) code to each sample container received in the laboratory. The use of container shape, size or other physical characteristic, such as amber glass, or purple top, is not an acceptable means of identifying the sample.

b) This laboratory code shall maintain an unequivocal link with the unique field ID code assigned each container.

c) The laboratory ID code shall be placed on the sample container as a durable label.

d) The laboratory ID code shall be entered into the laboratory records (see 5.5.8.3.1.d) and shall be the link that associates the sample with related laboratory activities such as sample preparation.

e) In cases where the sample collector and analyst are the same individual, or the laboratory preassigns numbers to sample containers, the laboratory ID code may be the same as the field ID code.

5.5.8.3 Upon receipt of the samples, the condition, including any abnormalities or departures from normal or specified conditions as described in the environmental test method, shall be recorded. When there is doubt as to the suitability of a sample for environmental test, or when a sample does not conform to the description provided, or the environmental test required is not specified in sufficient detail, the laboratory shall consult the client for further instructions before proceeding and shall record the discussion.

5.5.8.3.1 Sample Receipt Protocols

a) All items specified in 5.5.8.3.2 below shall be checked.

1) All samples which require thermal preservation shall be considered acceptable if the arrival temperature is either within 2°C of the required temperature or the method specified range. For samples with a specified temperature of 4°C, samples with a temperature ranging from just above the freezing temperature of water to 6°C shall be acceptable. Samples that are hand delivered to the laboratory on the same day that they are collected may not meet these criteria. In these cases, the samples shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice.

2) The laboratory shall implement procedures for checking chemical preservation using readily available techniques, such as pH or chlorine, prior to or during sample preparation or analysis.

3) Microbiological samples from chlorinated water systems do not require an additional chlorine residual check in the laboratory if the following conditions are met:

i. sufficient sodium thiosulfate is added to each container to neutralize at minimum 5 mg/l of chlorine for drinking water and 15mg/l of chlorine for wastewater samples;

ii. one container from each batch of laboratory prepared containers or lot of purchased ready-to-use containers is checked to ensure efficacy of the sodium thiosulfate to 5 mg/l chlorine or 15mg/l chlorine as appropriate and the check is documented;

iii. chlorine residual is checked in the field and actual concentration is documented with sample submission.

b) The results of all checks shall be recorded.

c) If the sample does not meet the sample receipt acceptance criteria listed in this standard, the laboratory shall either:

1) retain correspondence and/or records of conversations concerning the final disposition of rejected samples; or

2) fully document any decision to proceed with the analysis of samples not meeting acceptance criteria.

i. The condition of these samples shall, at a minimum, be noted on the chain of custody or transmittal form and laboratory receipt documents.

ii. The analysis data shall be appropriately "qualified" on the final report.

d) The laboratory shall utilize a permanent chronological record such as a log book or electronic database to document receipt of all sample containers.

1) This sample receipt log shall record the following:

i. client/project name,

ii. date and time of laboratory receipt,

iii. unique laboratory ID code (see 5.5.8.2), and,

iv. signature or initials of the person making the entries.

2) During the log-in process, the following information must be unequivocally linked to the log record or included as a part of the log. If such information is recorded/documented elsewhere, the records shall be part of the laboratory's permanent records, easily retrievable upon request and readily available to individuals who will process the sample. Note: the placement of the laboratory ID number on the sample container is not considered a permanent record.

i. The field ID code which identifies each container must be linked to the laboratory ID code in the sample receipt log.

ii. The date and time of sample collection must be linked to the sample container and to the date and time of receipt in the laboratory.

iii. The requested analyses (including applicable approved test method numbers) must be linked to the laboratory ID code.

iv. Any comments resulting from inspection for sample rejection shall be linked to the laboratory ID code.

e) All documentation, such as memos or transmittal forms, that is transmitted to the laboratory by the sample transmitter shall be retained.

f) A complete chain of custody record form (Sections 5.4.12.2.5 and Appendix E), if utilized, shall be maintained.

5.5.8.3.2 Sample Acceptance Policy

The laboratory must have a written sample acceptance policy that clearly outlines the circumstances under which samples shall be accepted or rejected. Data from any samples which do not meet the following criteria must be flagged in an unambiguous manner clearly defining the nature and substance of the variation. This sample acceptance policy shall be made available to sample collection personnel and shall include, but is not limited to, the following areas of concern:

a) proper, full, and complete documentation, which shall include sample identification, the location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample;

b) proper sample labeling to include unique identification and a labeling system for the samples with requirements concerning the durability of the labels (water resistant) and the use of indelible ink;

c) use of appropriate sample containers;

d) adherence to specified holding times;

e) adequate sample volume. Sufficient sample volume must be available to perform the necessary tests; and

f) procedures to be used when samples show signs of damage, contamination or inadequate preservation.

5.5.8.4 The laboratory shall have procedures and appropriate facilities for avoiding deterioration, contamination, loss or damage to the sample during storage, handling, preparation and testing. Handling instructions provided with the sample shall be followed. When samples have to be stored or conditioned under specified environmental conditions, these conditions shall be maintained, monitored and recorded. Where a sample or a portion of a sample is to be held secure, the laboratory shall have arrangements for storage and security that protect the condition and integrity of the secured samples or portions concerned.

a) Samples shall be stored according to the conditions specified by preservation protocols:

1) Samples which require thermal preservation shall be stored under refrigeration which is +/-2 of the specified preservation temperature unless method specific criteria exist. For samples with a specified storage temperature of 4°C, storage at a temperature above the freezing point of water to 6°C shall be acceptable.

2) Samples shall be stored away from all standards, reagents, food and other potentially contaminating sources. Samples shall be stored in such a manner to prevent cross contamination.

b) Sample fractions, extracts, leachates and other sample preparation products shall be stored according to 5.5.8.4.a above or according to specifications in the test method.

1) The laboratory shall have SOPs for the disposal of samples, digestates, leachates and extracts or other sample preparation products.

5.5.9 Assuring the Quality of Environmental Test and Calibration Results

5.5.9.1 General

The laboratory shall have quality control procedures for monitoring the validity of environmental tests undertaken. The resulting data shall be recorded in such a way that trends are detectable and, where practicable, statistical techniques shall be applied to the reviewing of the results. This monitoring shall be planned and reviewed and may include, but not be limited to, the following:

a) regular use of certified reference materials and/or internal quality control using secondary reference materials;

b) participation in interlaboratory comparison or proficiency-testing program (see Chapter 2)

c) replicate tests using the same or different methods;

d) retesting of retained samples;

e) correlation of results for different characteristics of a sample (for example, total phosphate should be greater than or equal to orthophosphate).

5.5.9.2 Essential Quality Control Procedures

These general quality control principles shall apply, where applicable, to all testing laboratories. The manner in which they are implemented is dependent on the types of tests performed by the laboratory (i.e., chemical, whole effluent toxicity, microbiological, radiological, air) and are further described in Appendix D. The standards for any given test type shall assure that the applicable principles are addressed:

a) All laboratories shall have detailed written protocols in place to monitor the following quality controls:

1) positive and negative controls to monitor tests such as blanks, spikes, reference toxicants;

2) tests to define the variability and/or repeatability of the laboratory results such as replicates;

3) measures to assure the accuracy of the test method including calibration and/or continuing calibrations, use of certified reference materials, proficiency test samples, or other measures;

4) measures to evaluate test method capability, such as limit of detection and limit of quantitation or range of applicability such as linearity;

5) selection of appropriate formulae to reduce raw data to final results such as regression analysis, comparison to internal/external standard calculations, and statistical analyses;

6) selection and use of reagents and standards of appropriate quality;

7) measures to assure the selectivity of the test for its intended purpose; and

8) measures to assure constant and consistent test conditions (both instrumental and environmental) where required by the test method such as temperature, humidity, light, or specific instrument conditions.

b) All quality control measures shall be assessed and evaluated on an on-going basis, and quality control acceptance criteria shall be used to determine the usability of the data. (See Appendix D.)

c) The laboratory shall have procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exist. (See 5.5.8.3.2, Sample Acceptance Policy.)

d) The quality control protocols specified by the laboratory's method manual (5.5.4.1.2) shall be followed. The laboratory shall ensure that the essential standards outlined in Appendix D or mandated methods or regulations (whichever are more stringent) are incorporated into their method manuals. When it is not apparent which is more stringent the QC in the mandated method or regulations is to be followed.

The essential quality control measures for testing are found in Appendix D of this Chapter.

5.5.10 Reporting the Results

5.5.10.1 General

The results of each test, or series of environmental tests carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the environmental test.

The results shall be reported, in a test report, and shall include all the information requested by the client and necessary for the interpretation of the environmental test or calibration results and all information required by the method used. This information is normally that required by 5.5.10.2, and 5.5.10.3

In the case of environmental tests performed for internal clients, or in the case of a written agreement with the client, the results may be reported in a simplified way. Any information listed in 5.5.10.2 to 5.5.10.4 which is not reported to the client shall be readily available in the laboratory which carried out the environmental tests.

Some regulatory reporting requirements or formats such as monthly operating reports may not require all items listed below, however, the laboratory shall provide all the required information to their client for use in preparing such regulatory reports.

Laboratories that are operated by a facility and whose sole function is to provide data to the facility management for compliance purposes (in-house or captive laboratories) shall have all applicable information specified in a) through m) below readily available for review by the accrediting authority. However, formal reports detailing the information are not required if:

a) the in-house laboratory is itself responsible for preparing the regulatory reports; or

b) the laboratory provides information to another individual within the organization for preparation of regulatory reports. The facility management must ensure that the appropriate report items are in the report to the regulatory authority if such information is required.

5.5.10.2 Test Reports

Each test report shall include at least the following information, unless the laboratory has valid reasons for not doing so, as indicated by 5.5.10.1.a and b:

a) a title (e.g. "Test Report," "Certificate of Results," or "Laboratory Results");

b) the name and address of the laboratory, the location where the environmental tests were carried out, if different from the address of the laboratory, and phone number with name of contact person for questions;

c) unique identification of the test report (such as the serial number), and on each page an identification in order to ensure that the page is recognized as a part of the test report and a clear identification of the end of the test report;

    1) This requirement may be presented in several ways:

        i. The total number of pages may be listed on the first page of the report as long as the subsequent pages are identified by the unique report identification and consecutive numbers, or

        ii. Each page is identified with the unique report identification. The pages are identified as a number of the total report pages (example: 3 of 10, or 1 of 20).

    2) Other methods of identifying the pages in the report may be acceptable as long as it is clear to the reader that discrete pages are associated with a specific report, and that the report contains a specified number of pages.

d) the name and address of the client and project name if applicable;

e) identification of the method used;

f) a description of, the condition of, and unambiguous identification of the sample(s), including the client identification code;

g) the date of receipt of the sample(s) where this is critical to the validity and application of the results, date and time of sample collection, the date(s) of performance of the environmental test, and time of sample preparation and/or analysis if the required holding time for either activity is less than or equal to 72 hours;

h) reference to the sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results;

i) the environmental test results with, where appropriate, the units of measurement, and any failures identified; identify whether data are calculated on a dry weight or wet weight basis; identify the reporting units such as µg/l or mg/kg; and for Whole Effluent Toxicity, identify the statistical package used to provide data;

j) the name(s), function(s) and signature(s) or equivalent electronic identification of person(s) authorizing the test report, and date of issue;

k) a statement to the effect that the results relate only to the samples;

l) at the laboratory's discretion, a statement that the certificate or report shall not be reproduced except in full, without the written approval of the laboratory;

m) Laboratories accredited to be in compliance with these standards shall certify that the test results meet all requirements of NELAC or provide reasons and/or justification if they do not.

5.5.10.3 Supplemental Information for Test Reports

5.5.10.3.1 In addition to the requirements listed in 5.5.10.2, test reports shall, where necessary for the interpretation of the test results, include the following:

a) deviations from (such as failed quality control), additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions and any non-standard conditions that may have affected the quality of results, including the use and definitions of data qualifiers;

b) where quality system requirements are not met, a statement of compliance/non-compliance with requirements and/or specifications, including identification of test results derived from any sample that did not meet NELAC sample acceptance requirements such as improper container, holding time, or temperature;

c) where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed when a client's instruction so requires;

d) where appropriate and needed, opinions and interpretations (see 5.5.10.4);

e) additional information which may be required by specific methods, clients or groups of clients;

f) qualification of numerical results with values outside the working range.

5.5.10.3.2 In addition to the requirements listed in 5.5.10.2 and 5.5.10.3.1, test reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:

a) the date of sampling;

b) unambiguous identification of the substance, material or product sampled (including the name of the manufacturer, the model or type of designation and serial numbers as appropriate);

c) the location of sampling, including any diagrams, sketches or photographs;

d) a reference to the sampling plan and procedures used;

e) details of any environmental conditions during sampling that may affect the interpretation of the test results;

f) any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

5.5.10.4 Opinions and Interpretations

When opinions and interpretations are included, the laboratory shall document the basis upon which the opinions and interpretations have been made. Opinions and interpretations shall be clearly marked as such in a test report.

5.5.10.5 Environmental Testing Obtained from Subcontractors

When the test report contains results of tests performed by subcontractors, these results shall be clearly identified by subcontractor name or applicable accreditation number. The subcontractor shall report the results in writing or electronically. The laboratory shall make a copy of the subcontractor's report available to the client when requested by the client.

5.5.10.6 Electronic Transmission of Results

In the case of transmission of environmental test results by telephone, telex, facsimile or other electronic or electromagnetic means, the requirements of this Standard shall be met and ensure that all reasonable steps are taken to preserve confidentiality (see also 5.5.4.7).

5.5.10.7 Format of Reports

The format shall be designed to accommodate each type of environmental test carried out and to minimize the possibility of misunderstanding or misuse.

5.5.10.8 Amendments to Test Reports

Material amendments to a test report after issue shall be made only in the form of a further document, or data transfer, which includes the statement:

"Supplement to Test Report, serial number ... [or as otherwise identified]", or an equivalent form of wording.

Such amendments shall meet all the requirements of this Standard.

When it is necessary to issue a complete new test report, this shall be uniquely identified and shall contain a reference to the original that it replaces.

QUALITY SYSTEMS
APPENDIX C

DEMONSTRATION OF CAPABILITY

Appendix C - DEMONSTRATION OF CAPABILITY

C.1 PROCEDURE FOR DEMONSTRATION OF CAPABILITY

A demonstration of capability (DOC) must be made prior to using any test method, and at any time there is a change in instrument type, personnel or test method (see 5.5.4.2.2).

Note: In laboratories with specialized "work cells" (a well defined group of analysts that together perform the method analysis), the group as a unit must meet the above criteria and this demonstration must be fully documented.

In general, this demonstration does not test the performance of the method in real world samples, but in the applicable and available quality system matrix (a sample in which no target analytes or interferences are present at concentrations that impact the results of a specific test method), e.g., drinking water, solids, biological tissue and air. However, before any results are reported using this method, actual sample spike results may be used to meet this standard, i.e., at least four consecutive matrix spikes within the last twelve months. In addition, for analytes which do not lend themselves to spiking, e.g., TSS, the demonstration of capability may be performed using quality control samples.

All demonstrations shall be documented through the use of the form in this appendix. All data applicable to the demonstration need not be attached to the form, but must be retained and available.

When an analyte not currently found on the laboratory's list of accredited analytes is added to an existing accredited test method, an initial evaluation must be performed for that analyte.

The following steps shall be performed if required by mandatory test method or regulation. It is the responsibility of the laboratory to document that other approaches to DOC are adequate, this shall be documented in the laboratory's Quality Manual, e.g., for Whole Effluent Toxicity Testing see section D.2.1.a.1.

a) A quality control sample shall be obtained from an outside source. If not available, the QC sample may be prepared by the laboratory using stock standards that are prepared independently from those used in instrument calibration.

b) The analyte(s) shall be diluted in a volume of clean quality system matrix sufficient to prepare four aliquots at the concentration specified, or if unspecified, to a concentration of 1-4 times the limit of quantitation.

c) At least four aliquots shall be prepared and analyzed according to the test method either concurrently or over a period of days.

d) Using all of the results, calculate the mean recovery in the appropriate reporting units and the standard deviations of the population sample (n-1) (in the same units) for each parameter of interest. When it is not possible to determine mean and standard deviations, such as for presence/absence and logarithmic values, the laboratory must assess performance against established and documented criteria.

e) Compare the information from (d) above to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria (if there are not established mandatory criteria). If all parameters meet the acceptance criteria, the analysis of actual samples may begin. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter.

f) When one or more of the tested parameters fail at least one of the acceptance criteria, the analyst must proceed according to 1) or 2) below.

1) Locate and correct the source of the problem and repeat the test for all parameters of interest beginning with c) above.

2) Beginning with c) above, repeat the test for all parameters that failed to meet criteria. Repeated failure, however, confirms a general problem with the measurement system. If this occurs, locate and correct the source of the problem and repeat the test for all compounds of interest beginning with c).

C.2 CERTIFICATION STATEMENT

The following certification statement shall be used to document the completion of each demonstration of capability. A copy of the certification statement shall be retained in the personnel records of each affected employee (see 5.5.2.5 and 5.4.12.2.5.4.b).

Demonstration of Capability
Certification Statement

Date: Page __of __
Laboratory Name:
Laboratory Address:
Analyst(s) Name(s):

Matrix:
(examples: laboratory pure water, soil, air, solid, biological tissue)
Method number, SOP#, Rev#, and Analyte, or Class of Analytes or Measured Parameters
(examples: barium by 200.7, trace metals by 6010, benzene by 8021, etc.)

We, the undersigned, CERTIFY that:

1. The analysts identified above, using the cited test method(s), which is in use at this facility for the analyses of samples under the National Environmental Laboratory Accreditation Program, have met the Demonstration of Capability.

2. The test method(s) was performed by the analyst(s) identified on this certification.

3. A copy of the test method(s) and the laboratory-specific SOPs are available for all personnel on-site.

4. The data associated with the demonstration capability are true, accurate, complete and self-explanatory (1).

5. All raw data (including a copy of this certification form) necessary to reconstruct and validate these analyses have been retained at the facility, and that the associated information is well organized and available for review by authorized assessors.

Technical Director's Name and Title	Signature	Date
Quality Assurance Officer's Name	Signature	Date

This certification form must be completed each time a demonstration of capability study is completed.

(1) True: Consistent with supporting data.

Accurate: Based on good laboratory practices consistent with sound scientific principles/practices.

Complete: Includes the results of all supporting performance testing.

Self-Explanatory: Data properly labeled and stored so that the results are clear and require no additional explanation.

C.3 INITIAL TEST METHOD EVALUATION

For all test methods other than toxicity and microbiology the requirements of C.3.1 and C.3.2 apply. For Toxicity testing, and Microbiology testing, the initial test method evaluation requirements are contained at Appendix D.2. and D.3., respectively. For the evaluation of precision and bias (C.3.3), the requirements of C.3.3(a) apply to standard methods. The requirements of C.3.3(b) apply to the methods referenced therein.

C.3.1. Limit of Detection (LOD)

a) The laboratory shall determine the LOD for the method for each target analyte of concern in the quality system matrices. All sample-processing steps of the analytical method shall be included in the determination of the LOD.

b) The validity of the LOD shall be confirmed by qualitative identification of the analyte(s) in a QC sample in each quality system matrix containing the analyte at no more than 2-3X the LOD for single analyte tests and 1-4X the LOD for multiple analyte tests. This verification must be performed on every instrument that is to be used for analysis of samples and reporting of data.

c) An LOD study is not required for any component for which spiking solutions or quality control samples are not available such as temperature, or, when test results are not to be reported to the LOD (versus the limit of quantitation or working range of instrument calibration), according to Appendices D.1.2, D.4.5, D.5.4, and D.6.6. Where an LOD study is not performed, the laboratory may not report a value below the Limit of Quantitation.

C.3.2. Limit of Quantitation (LOQ)

a) The laboratory shall determine the LOQ for each analyte of concern according to a defined, documented procedure.

b) The LOQ study is not required for any component or property for which spiking solutions or quality control samples are not commercially available or otherwise inappropriate (e.g., pH).

c) The validity of the LOQ shall be confirmed by successful analysis of a QC sample containing the analytes of concern in each quality system matrix 1-2 times the claimed LOQ. A successful analysis is one where the recovery of each analyte is within the established test method acceptance criteria or client data quality objectives for accuracy. This single analysis is not required if the bias and precision of the measurement system is evaluated at the LOQ.

C.3.3. Evaluation of Precision and Bias

a) Standard methods -- The laboratory shall evaluate the Precision and Bias of a Standard Method for each analyte of concern for each quality system matrix according to the single-concentration four-replicate recovery study procedures in Appendix C.1 above (or alternate procedure documented in the quality manual when the analyte cannot be spiked into the sample matrix and QC samples are not commercially available).

b) Non-standard methods -- For Laboratory-developed test methods or non-standard test methods as defined at 5.5.4.3 and 5.5.4.4. that were not in use by the laboratory before July 2003, the laboratory must have a documented procedure to evaluate precision and bias. The laboratory must also compare results of the precision and bias measurements with criteria established by the client, by criteria given in the reference method or criteria established by the laboratory.

Precision and bias measurements must evaluate the method across the analytical calibration range of the method. The laboratory must also evaluate precision and bias in the relevant quality system matrices and must process the samples through the entire measurement system for each analyte of interest.

Examples of a systematic approach to evaluate precision and bias could be the following:

Analyze QC samples in triplicate containing the analytes of concern at or near the limit of quantitation, at the upper-range of the calibration (upper 20%) and at a mid-range concentration. Process these samples on different days as three sets of samples through the entire measurement system for each analyte of interest. Each day one QC sample at each concentration is analyzed. A separate method blank shall be subjected to the analytical method along with the QC samples on each of the three days. (Note that the three samples at the LOQ concentration can demonstrate sensitivity as well.) For each analyte, calculate the mean recovery for each day, for each level over days, and for all nine samples. Calculate the relative standard deviation for each of the separate means obtained. Compare the standard deviations for the different days and the standard deviations for the different concentrations. If the different standard deviations are all statistically insignificant (e.g., F-test), then compare the overall mean and standard deviation with the established criteria from above.

A validation protocol such as the Tier I, Tier II, and Tier III requirements in US EPA Office of Water's Alternate Test Procedure (ATP) approval process.

C.3.4. Evaluation of Selectivity

The laboratory shall evaluate selectivity by following the checks established within the method, which may include mass spectral tuning, second column confirmation, ICP inter-element interference checks, chromatography retention time windows, sample blanks, spectrochemical absorption or fluorescence profiles, co-precipitation evaluations, and electrode response factors.

QUALITY SYSTEMS
APPENDIX D

ESSENTIAL QUALITY CONTROL REQUIREMENTS

Appendix D - ESSENTIAL QUALITY CONTROL REQUIREMENTS

The quality control protocols specified by the laboratory's method manual (5.5.4.1.2) shall be followed. The laboratory shall ensure that the essential standards outlined in Appendix D are incorporated into their method manuals and/or the Laboratory Quality Manual.

All quality control measures shall be assessed and evaluated on an on-going basis and quality control acceptance criteria shall be used to determine the validity of the data. The laboratory shall have procedures for the development of acceptance/rejection criteria where no method or regulatory criteria exists.

The requirements from the body of Chapter 5, e.g., 5.5.9.2, apply to all types of testing. The specific manner in which they are implemented is detailed in each of the sections of this Appendix, i.e., chemical testing, W.E.T. testing, microbiology testing, radiochemical testing and air testing.

D.1 CHEMICAL TESTING

D.1.1 Positive and Negative Controls

D.1.1.1 Negative Control - Method Performance

a) Purpose: The method blank is used to assess the preparation batch for possible contamination during the preparation and processing steps. The method blank shall be processed along with and under the same conditions as the associated samples to include all steps of the analytical procedure. Procedures shall be in place to determine if a method blank is contaminated. Any affected samples associated with a contaminated method blank shall be reprocessed for analysis or the results reported with appropriate data qualifying codes.

b) Frequency: The method blank shall be analyzed at a minimum of 1 per preparation batch. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

c) Composition: The method blank shall consist of a quality system matrix that is similar to the associated samples and is known to be free of the analytes of interest.

d) Evaluation Criteria and Corrective Action: While the goal is to have no detectable contaminants, each method blank must be critically evaluated as to the nature of the interference and the effect on the analysis of each sample within the batch. The source of contamination shall be investigated and measures taken to minimize or eliminate the problem and affected samples reprocessed or data shall be appropriately qualified if:

    1) The concentration of a targeted analyte in the blank is at or above the reporting limit as established by the test method or by regulation, AND is greater than 1/10 of the amount measured in any sample.

2) The blank contamination otherwise affects the sample results as per the test method requirements or the individual project data quality objectives.

3) When a blank is determined to be contaminated, the cause must be investigated and measures taken to minimize or eliminate the problem. Samples associated with a contaminated blank shall be evaluated as to the best corrective action for the samples (e.g. reprocessing or data qualifying codes). In all cases the corrective action must be documented.

D.1.1.2 Positive Control - Method Performance

D.1.1.2.1 Laboratory Control Sample (LCS)

a) Purpose: The LCS is used to evaluate the performance of the total analytical system, including all preparation and analysis steps. Results of the LCS are compared to established criteria and, if found to be outside of these criteria, indicates that the analytical system is "out of control". Any affected samples associated with an out of control LCS shall be reprocessed for re-analysis or the results reported with appropriate data qualifying codes.

b) Frequency: The LCS shall be analyzed at a minimum of 1 per preparation batch. Exceptions would be for those analytes for which no spiking solutions are available such as total suspended solids, total dissolved solids, total volatile solids, total solids, pH, color, odor, temperature, dissolved oxygen or turbidity. In those instances for which no separate preparation method is used (example: volatiles in water) the batch shall be defined as environmental samples that are analyzed together with the same method and personnel, using the same lots of reagents, not to exceed the analysis of 20 environmental samples.

c) Composition: The LCS is a quality system matrix, known to be free of analytes of interest, spiked with known and verified concentrations of analytes. NOTE: the matrix spike may be used in place of this control as long as the acceptance criteria are as stringent as for the LCS. Alternatively the LCS may consist of a media containing known and verified concentrations of analytes or as Certified Reference Material (CRM). All analyte concentrations shall be within the calibration range of the methods. The following shall be used in choosing components for the spike mixtures:

The components to be spiked shall be as specified by the mandated test method or other regulatory requirement or as requested by the client. In the absence of specified spiking components the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen. The analytes selected should be representative of all analytes reported. The following criteria shall be used for determining the minimum number of

analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a 2-year period.

1) For methods that include 1-10 targets, spike all components;

2) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;

3) For methods with more than 20 targets, spike at least 16 components.

d) Evaluation Criteria and Corrective Action: The results of the individual batch LCS are calculated in percent recovery or other appropriate statistical technique that allows comparison to established acceptance criteria. The laboratory shall document the calculation.

The individual LCS is compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits or utilize client specified assessment criteria.

A LCS that is determined to be within the criteria effectively establishes that the analytical system is in control and validates system performance for the samples in the associated batch. Samples analyzed along with a LCS determined to be "out of control" shall be considered suspect and the samples reprocessed and re-analyzed or the data reported with appropriate data qualifying codes.

e) If a large number of analytes are in the LCS, it becomes statistically likely that a few will be outside control limits. This may not indicate that the system is out of control, therefore corrective action may not be necessary. Upper and lower marginal exceedance (ME) limits can be established to determine when corrective action is necessary. A ME is defined as being beyond the LCS control limit (3 standard deviations), but within the ME limits. ME limits are between 3 and 4 standard deviations around the mean.

The number of allowable marginal exceedances is based on the number of analytes in the LCS. If more analytes exceed the LCS control limits than is allowed, or if any one analyte exceeds the ME limits, the LCS fails and corrective action is necessary. This marginal exceedance approach is relevant for methods with long lists of analytes. It will not apply to target analyte lists with fewer than 11 analytes.

The number of allowable marginal exceedances is as follows:

1) >90 analytes in LCS, 5 analytes allowed in ME of the LCS control limit;

2) 71-90 analytes in LCS, 4 analytes allowed in ME of the LCS control limit;

3) 51-70 analytes in LCS, 3 analytes allowed in ME of the LCS control limit;

4) 31-50 analytes in LCS, 2 analytes allowed in ME of the LCS control limit;

5) 11-30 analytes in LCS, 1 analytes allowed in ME of the LCS control limit;

6) <11 analytes in LCS, no analytes allowed in ME of the LCS control limit;

Marginal exceedances must be random. If the same analyte exceeds the LCS control limit repeatedly, it is an indication of a systemic problem. The source of the error must be located and corrective action taken. Laboratories must have a written procedure to monitor the application of marginal exceedance allowance to the LCS to ensure random behavior.

D.1.1.3 Sample Specific Controls

The laboratory must document procedures for determining the effect of the sample matrix on method performance. These procedures relate to the analyses of quality system matrix specific Quality Control (QC) samples and are designed as data quality indicators for a specific sample using the designated test method. These controls alone are not used to judge laboratory performance.

Examples of matrix specific QC include: Matrix Spike (MS); Matrix Spike Duplicate (MSD); sample duplicates; and surrogate spikes. The laboratory shall have procedures in place for tracking, managing, and handling matrix specific QC criteria including spiking appropriate components at appropriate concentrations, calculating recoveries and relative percent difference, evaluating and reporting results based on performance of the QC samples.

D.1.1.3.1 Matrix Spike; Matrix Spike Duplicates

a) Purpose: Matrix specific QC samples indicate the effect of the sample matrix on the precision and accuracy of the results generated using the selected method. The information from these controls is sample/matrix specific and would not normally be used to determine the validity of the entire batch.

b) Frequency: The frequency of the analysis of matrix specific samples shall be determined as part of a systematic planning process (e.g. Data Quality Objectives) or as specified by the test method.

c) Composition: The components to be spiked shall be as specified by the mandated test method. Any permit specified analytes, as specified by regulation or client requested analytes shall also be included. If there are no specified components, the laboratory shall spike per the following:

For those components that interfere with an accurate assessment such as spiking simultaneously with technical chlordane, toxaphene and PCBs, the spike should be chosen that represents the chemistries and elution patterns of the components to be reported.

For those test methods that have extremely long lists of analytes, a representative number may be chosen using the following criteria for choosing the number of analytes to be spiked. However, the laboratory shall insure that all targeted components are included in the spike mixture over a 2 year period.

1) For methods that include 1-10 targets, spike all components;

2) For methods that include 11-20 targets, spike at least 10 or 80%, whichever is greater;

3) For methods with more than 20 targets, spike at least 16 components.

d) Evaluation Criteria and Corrective Action: The results from matrix spike/matrix spike duplicate are primarily designed to assess the precision and accuracy of analytical results in a given matrix and are expressed as percent recovery (%R), relative percent difference (RPD), or other appropriate statistical technique that allows comparison to established acceptance criteria. The laboratory shall document the calculation for %R, RPD or other statistical treatment used.

The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits. For matrix spike results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

D.1.1.3.2 Matrix Duplicates

a) Purpose: Matrix duplicates are defined as replicate aliquots of the same sample taken through the entire analytical procedure. The results from this analysis indicate the precision of the results for the specific sample using the selected method. The matrix duplicate provides a usable measure of precision only when target analytes are found in the sample chosen for duplication.

b) Frequency: The frequency of the analysis of matrix duplicates may be determined as part of a systematic planning process (e.g. Data Quality Objectives) or as specified by the mandated test method.

c) Composition: Matrix duplicates are performed on replicate aliquots of actual samples. The composition is usually not known.

d) Evaluation Criteria and Corrective Action: The results from matrix duplicates are primarily designed to assess the precision of analytical results in a given matrix and are expressed as relative percent difference (RPD) or another statistical treatment (e.g., absolute differences). The laboratory shall document the calculation for relative percent difference or other statistical treatments.

Results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory shall determine internal criteria and document the method used to establish the limits. For matrix duplicates results outside established criteria corrective action shall be documented or the data reported with appropriate data qualifying codes.

D.1.1.3.3 Surrogate Spikes

a) Purpose: Surrogates are used most often in organic chromatography test methods and are chosen to reflect the chemistries of the targeted components of the method. Added

prior to sample preparation/extraction, they provide a measure of recovery for every sample matrix.

b) Frequency: Except where the matrix precludes its use or when not commercially available, surrogate compounds must be added to all samples, standards, and blanks for all appropriate test methods.

c) Composition: Surrogate compounds are chosen to represent the various chemistries of the target analytes in the method or MQO. They are often specified by the mandated method and are deliberately chosen for their being unlikely to occur as an environmental contaminant. Often this is accomplished by using deuterated analogs of select compounds.

b) Evaluation Criteria and Corrective Action: The results are compared to the acceptance criteria as published in the mandated test method. Where there are no established criteria, the laboratory should determine internal criteria and document the method used to establish the limits. Surrogates outside the acceptance criteria must be evaluated for the effect indicated for the individual sample results. The appropriate corrective action may be guided by the data quality objectives or other site specific requirements. Results reported from analyses with surrogate recoveries outside the acceptance criteria should include appropriate data qualifiers.

D.1.2 Limit of Detection and Limit of Quantitation

All procedures used must be documented. Documentation must include the quality system matrix type. All supporting data must be retained.

D.1.2.1 Limit of Detection (LOD)

The laboratory shall utilize a test method that provides an LOD that is appropriate and relevant for the intended use of the data. An LOD is not required for a test method when test results are not reported outside of the calibration range. LODs shall be determined by the protocol in the mandated test method or applicable regulation. If the protocol for determining LODs is not specified, the selection of the procedure must reflect instrument limitations and the intended application of the test method.

a) The LOD shall be initially determined for the compounds of interest in each test method in a quality system matrix in which there are not target analytes nor interferences at a concentration that would impact the results or the LOD must be determined in the quality system matrix of interest (see definition of matrix).

b) LODs must be determined each time there is a change in the test method that affects how the test is performed, or when a change in instrumentation occurs that affects the sensitivity of the analysis.

c) The laboratory must have established procedures to relate LOD with LOQ.

d) The LOD must be verified annually for each quality system matrix, method and analyte according to the procedure specified in C.3.

D.1.2.2 Limit of Quantitation (LOQ)

a) Any established LOQ must be above the LOD

b) The LOQ must be verified annually for each quality system matrix, method and analyte according to the procedure specified in C.3. Alternatively, the annual LOQ verification is not required if the LOD is reevaluated or verified according to D.1.2.d above.

D.1.3 Data Reduction

The procedures for data reduction, such as use of linear regression, shall be documented.

D.1.4 Quality of Standards and Reagents

a) The source of standards shall comply with 5.5.6.2.2.2.

b) Reagent Quality, Water Quality and Checks:

1) Reagents - In methods where the purity of reagents is not specified, analytical reagent grade shall be used. Reagents of lesser purity than those specified by the test method shall not be used. The labels on the container should be checked to verify that the purity of the reagents meets the requirements of the particular test method. Such information shall be documented.

2) Water - The quality of water sources shall be monitored and documented and shall meet method specified requirements.

3) The laboratory will verify the concentration of titrants in accordance with written laboratory procedures.

D.1.5 Selectivity

a) The laboratory shall evaluate selectivity by following the checks established within the method, which may include mass spectral tuning, second column confirmation, ICP inter-element interference checks, chromatography retention time windows, sample blanks, spectrochemical absorption or fluorescence profiles, co-precipitation evaluations, and electrode response factors.

b) A confirmation shall be performed to verify the compound identification when positive results are detected on a sample from a location that has not been previously tested by the laboratory. Such confirmations shall be performed on organic tests such as pesticides, herbicides, or acid extractable or when recommended by the analytical test method except when the analysis involves the use of a mass spectrometer. Confirmation is required unless stipulated in writing by the client. All confirmation shall be documented.

c) The laboratory shall document acceptance criteria for mass spectral tuning.

D.1.6 Constant and Consistent Test Conditions

a) The laboratory shall assure that the test instruments consistently operate within the specifications required of the application for which the equipment is used.

b) Glassware Cleaning - Glassware shall be cleaned to meet the sensitivity of the test method.

Any cleaning and storage procedures that are not specified by the test method shall be documented in laboratory records and SOPs.

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D.3 MICROBIOLOGY TESTING

These standards apply to laboratories undertaking microbiological analysis of environmental samples. Microbiological testing refers to and includes the detection, isolation, enumeration, or identification of microorganisms and/or their metabolites, or determination of the presence or absence of growth in materials and media.

D.3.1 Sterility Checks and Blanks, Positive and Negative Controls

a) Sterility Checks and Blanks

The laboratory shall demonstrate that the filtration equipment and filters, sample containers, media and reagents have not been contaminated through improper handling or preparation, inadequate sterilization, or environmental exposure.

1) A sterility blank shall be analyzed for each lot of pre-prepared, ready-to-use medium (including chromofluorogenic reagent) and for each batch of medium prepared in the laboratory. This shall be done prior to first use of the medium.

2) For filtration technique, the laboratory shall conduct one beginning and one ending sterility check for each laboratory sterilized filtration unit used in a filtration series. The filtration series may include single or multiple filtration units, which have been sterilized prior to beginning the series. For pre-sterilized single use funnels a sterility check shall be performed on one funnel per lot. The filtration series is considered ended when more than 30 minutes elapses between successive filtrations. During a filtration series, filter funnels must be rinsed with three 20-30 ml portions of sterile rinse water after each sample filtration. In addition, laboratories must insert a sterility blank after every 10 samples or sanitize filtration units by UV light after each sample filtration.

3) For pour plate technique, sterility blanks of the medium shall be made by pouring, at a minimum, one uninoculated plate for each lot of pre-prepared, ready-to-use media and for each batch of medium prepared in the laboratory.

4) Sterility checks on sample containers shall be performed on at least one container for each lot of purchased, pre-sterilized containers. For containers prepared and sterilized in the laboratory, a sterility check shall be performed on one container per sterilized batch with non-selective growth media.

5) A sterility blank shall be performed on each batch of dilution water prepared in the laboratory and on each batch of pre-prepared, ready-to-use dilution water with non-selective growth media.

6) At least one filter from each new lot of membrane filters shall be checked for sterility with non-selective growth media.

b) Positive Controls

Positive culture controls demonstrate that the medium can support the growth of the target organism(s), and that the medium produces the specified or expected reaction to the target organism(s).

1) Each pre-prepared, ready-to-use lot of medium (including chromofluorogenic reagent) and each batch of medium prepared in the laboratory shall be tested with at least one pure culture of a known positive reaction. This shall be done prior to first use of the medium.

c) Negative Controls

Negative culture controls demonstrate that the medium does not support the growth of non-target organisms or does not demonstrate the typical positive reaction of the target organism(s).

Each pre-prepared, ready-to-use lot of selective medium (including chromofluorogenic reagent) and each batch of selective medium prepared in the laboratory shall be analyzed with one or more known negative culture controls, i.e. non-target organisms, as appropriate to the method. This shall be done prior to first use of the medium.

D.3.2 Test Variability/Reproducibility

For test methods that specify colony counts such as membrane filter or plated media, duplicate counts shall be performed monthly on one positive sample, for each month that the test is performed. If the lab has two or more analysts, each analyst shall count typical colonies on the same plate. Counts must be within 10% difference to be acceptable. In a laboratory with only one microbiology analyst, the same plate shall be counted twice by the analyst, with no more than 5% difference between the counts.

D.3.3 Method Evaluation

a) Laboratories are required to demonstrate proficiency with the test method prior to first use. This shall be achieved by comparison to a method already approved for use in the laboratory, or by analyzing a minimum of ten spiked samples whose quality system matrix is representative of those normally submitted to the laboratory, or by analyzing and passing one proficiency test series provided by an approved proficiency sample provider. The laboratory shall maintain this documentation as long as the method is in use and for at least 5 years past the date of last use.

b) Laboratories shall participate in the Proficiency Test programs identified by NELAP (5.4.1.5.k or 5.5.9.1). The results of these analyses shall be used to evaluate the ability of the laboratory to produce acceptable data.

D.3.4 Test Performance

a) All growth and recovery media must be checked to assure that the target organism(s) respond in an acceptable and predictable manner (see D.3.1.b).

b) To ensure that analysis results are accurate, target organism identity shall be verified as specified in the method, e.g. by use of the completed test, or by use of secondary verification tests such as a catalase test.

D.3.5 Data Reduction

The calculations, data reduction and statistical interpretations specified by each test method shall be followed.

D.3.6 Quality of Standards, Reagents and Media

The laboratory shall ensure that the quality of the reagents and media used is appropriate for the test concerned.

a) Culture media may be prepared from commercial dehydrated powders or may be purchased ready to use. Media may be prepared by the laboratory from basic ingredients when commercial media are not available or when it can be demonstrated that

commercial media do not provide adequate results. Media prepared by the laboratory from basic ingredients must be tested for performance (e.g., for selectivity, sensitivity, sterility, growth promotion, growth inhibition) prior to first use. Detailed testing criteria information must be defined in either the laboratory's test methods, SOPs, Quality Manual, or similar documentation.

b) Reagents, commercial dehydrated powders and media shall be used within the shelf-life of the product and shall be documented according to 5.5.6.4.

c) Distilled water, deionized water or reverse-osmosis produced water free from bactericidal and inhibitory substances shall be used in the preparation of media, solutions and buffers. The quality of the water shall be monitored for chlorine residual, specific conductance, and heterotrophic bacteria plate count monthly (when in use), when maintenance is performed on the water treatment system, or at startup after a period of disuse longer than one month.

Analysis for metals and the Bacteriological Water Quality Test (to determine presence of toxic agents or growth promoting substances) shall be performed annually. Results of these analyses shall meet the specifications of the required method and records of analyses shall be maintained for five years. (An exception to performing the Bacteriological Water Quality Test shall be given to laboratories that can supply documentation to show that their water source meets the criteria, as specified by the method, for Type I or Type II reagent water.)

d) Media, solutions and reagents shall be prepared, used and stored according to a documented procedure following the manufacturer's instructions or the test method. Documentation for media prepared in the laboratory shall include date of preparation, preparer's initials, type and amount of media prepared, manufacturer and lot number, final pH of the media, and expiration date. Documentation for media purchased pre-prepared, ready-to-use shall include manufacturer, lot number, type and amount of media received, date of receipt, expiration date of the media, and pH of the media.

D.3.7 Selectivity

a) In order to ensure identity and traceability, reference cultures used for positive and negative controls shall be obtained from a recognized national collection, organization, or manufacturer recognized by the NELAP Accrediting Authority. Microorganisms may be single use preparations or cultures maintained by documented procedures that demonstrate the continued purity and viability of the organism.

1) Reference cultures may be revived (if freeze-dried) or transferred from slants and subcultured once to provide reference stocks. The reference stocks shall be preserved by a technique which maintains the characteristics of the strains. Reference stocks shall be used to prepare working stocks for routine work. If reference stocks have been thawed, they must not be re-frozen and re-used.

2) Working stocks shall not be sequentially cultured more than five times and shall not be subcultured to replace reference stocks.

D.3.8 Constant and Consistent Test Conditions

a) Laboratory Facilities

Floors and work surfaces shall be non-absorbent and easy to clean and disinfect. Work surfaces shall be adequately sealed. Laboratories shall provide sufficient storage space, and shall be clean and free from dust accumulation. Plants, food, and drink shall be prohibited from the laboratory work area.

b) Laboratory Equipment

1) Temperature Measuring Devices

Temperature measuring devices such as liquid-in-glass thermometers, thermocouples, and platinum resistance thermometers used in incubators, autoclaves and other equipment shall be the appropriate quality to meet specification(s) in the test method. The graduation of the temperature measuring devices must be appropriate for the required accuracy of measurement and they shall be calibrated to national or international standards for temperature (see 5.5.6.2.2.2). Calibration shall be done at least annually.

2) Autoclaves

i) The performance of each autoclave shall be initially evaluated by establishing its functional properties and performance, for example heat distribution characteristics with respect to typical uses. Autoclaves shall meet specified temperature tolerances. Pressure cookers shall not be used for sterilization of growth media.

ii) Demonstration of sterilization temperature shall be provided by use of continuous temperature recording device or by use of a maximum registering thermometer with every cycle. Appropriate biological indicators shall be used once per month to determine effective sterilization. Temperature sensitive tape shall be used with the contents of each autoclave run to indicate that the autoclave contents have been processed.

iii) Records of autoclave operations shall be maintained for every cycle. Records shall include: date, contents, maximum temperature reached, pressure, time in sterilization mode, total run time (may be recorded as time in and time out) and analyst's initials.

iv) Autoclave maintenance, either internally or by service contract, shall be performed annually and shall include a pressure check and calibration of temperature device. Records of the maintenance shall be maintained in equipment logs.

v) The autoclave mechanical timing device shall be checked quarterly against a stopwatch and the actual time elapsed documented.

3) Volumetric Equipment

Volumetric equipment shall be calibrated as follows:

i) equipment with movable parts such as automatic dispensers, dispensers/diluters, and mechanical hand pipettes shall be verified for accuracy quarterly.
ii) equipment such as filter funnels, bottles, non-class A glassware, and other marked containers shall be calibrated once per lot prior to first use.
iii) the volume of the disposable volumetric equipment such as sample bottles, disposable pipettes, and micropippette tips shall be checked once per lot.

4) UV Instruments

UV instruments, used for sanitization, shall be tested quarterly for effectiveness with an appropriate UV light meter or by plate count agar spread plates. Replace bulbs if output is less than 70% of original for light tests or if count reduction is less than 99% for a plate containing 200 to 300 organisms.

5) Conductivity meters, oxygen meters, pH meters, hygrometers, and other similar measurement instruments shall be calibrated according to the method specified requirements (see Section 5.5.5.2.1.d).

6) Incubators, Water Baths, Ovens

i) The stability and uniformity of temperature distribution and time required after test sample addition to re-establish equilibrium conditions in incubators and water baths shall be established. Temperature of incubators and water baths shall be documented twice daily, at least four hours apart, on each day of use.

ii) Ovens used for sterilization shall be checked for sterilization effectiveness monthly with appropriate biological indicators. Records shall be maintained for each cycle that include date, cycle time, temperature, contents and analyst's initials.

7) Labware (Glassware and Plasticware)

i) The laboratory shall have a documented procedure for washing labware, if applicable. Detergents designed for laboratory use must be used.

ii) Glassware shall be made of borosilicate or other non-corrosive material, free of chips and cracks, and shall have readable measurement marks.

iii) Labware that is washed and reused shall be tested for possible presence of residues which may inhibit or promote growth of microorganisms by performing the Inhibitory Residue Test annually, and each time the lab changes the lot of detergent or washing procedures.

iv) Washed labware shall be tested at least once daily, each day of washing, for possible acid or alkaline residue by testing at least one piece of labware with a suitable pH indicator such as bromothymol blue. Records of tests shall be maintained.

INTERNATIONAL STANDARD

ISO/IEC 17025

Second edition
2005-05-15

General requirements for the competence of testing and calibration laboratories

Exigences générales concernant la compétence des laboratoires d'étalonnages et d'essais

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of conformity assessment, the ISO Committee on conformity assessment (CASCO) is responsible for the development of International Standards and Guides.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

Draft International Standards are circulated to the national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 17025 was prepared by the *ISO Committee on conformity assessment* (CASCO).

It was circulated for voting to the national bodies of both ISO and IEC, and was approved by both organizations.

This second edition cancels and replaces the first edition (ISO/IEC 17025:1999), which has been technically revised.

Introduction

The first edition (1999) of this International Standard was produced as the result of extensive experience in the implementation of ISO/IEC Guide 25 and EN 45001, both of which it replaced. It contained all of the requirements that testing and calibration laboratories have to meet if they wish to demonstrate that they operate a management system, are technically competent, and are able to generate technically valid results.

The first edition referred to ISO 9001:1994 and ISO 9002:1994. These standards have been superseded by ISO 9001:2000, which made an alignment of ISO/IEC 17025 necessary. In this second edition, clauses have been amended or added only when considered necessary in the light of ISO 9001:2000.

Accreditation bodies that recognize the competence of testing and calibration laboratories should use this International Standard as the basis for their accreditation. Clause 4 specifies the requirements for sound management. Clause 5 specifies the requirements for technical competence for the type of tests and/or calibrations the laboratory undertakes.

Growth in the use of management systems generally has increased the need to ensure that laboratories which form part of larger organizations or offer other services can operate to a quality management system that is seen as compliant with ISO 9001 as well as with this International Standard. Care has been taken, therefore, to incorporate all those requirements of ISO 9001 that are relevant to the scope of testing and calibration services that are covered by the laboratory's management system.

Testing and calibration laboratories that comply with this International Standard will therefore also operate in accordance with ISO 9001.

Conformity of the quality management system within which the laboratory operates to the requirements of ISO 9001 does not of itself demonstrate the competence of the laboratory to produce technically valid data and results. Nor does demonstrated conformity to this International Standard imply conformity of the quality management system within which the laboratory operates to all the requirements of ISO 9001.

The acceptance of testing and calibration results between countries should be facilitated if laboratories comply with this International Standard and if they obtain accreditation from bodies which have entered into mutual recognition agreements with equivalent bodies in other countries using this International Standard.

The use of this International Standard will facilitate cooperation between laboratories and other bodies, and assist in the exchange of information and experience, and in the harmonization of standards and procedures.

General requirements for the competence of testing and calibration laboratories

1 Scope

1.1 This International Standard specifies the general requirements for the competence to carry out tests and/or calibrations, including sampling. It covers testing and calibration performed using standard methods, non-standard methods, and laboratory-developed methods.

1.2 This International Standard is applicable to all organizations performing tests and/or calibrations. These include, for example, first-, second- and third-party laboratories, and laboratories where testing and/or calibration forms part of inspection and product certification.

This International Standard is applicable to all laboratories regardless of the number of personnel or the extent of the scope of testing and/or calibration activities. When a laboratory does not undertake one or more of the activities covered by this International Standard, such as sampling and the design/development of new methods, the requirements of those clauses do not apply.

1.3 The notes given provide clarification of the text, examples and guidance. They do not contain requirements and do not form an integral part of this International Standard.

1.4 This International Standard is for use by laboratories in developing their management system for quality, administrative and technical operations. Laboratory customers, regulatory authorities and accreditation bodies may also use it in confirming or recognizing the competence of laboratories. This International Standard is not intended to be used as the basis for certification of laboratories.

NOTE 1 The term 'management system' in this International Standard means the quality, administrative and technical systems that govern the operations of a laboratory.

NOTE 2 Certification of a management system is sometimes also called registration.

1.5 Compliance with regulatory and safety requirements on the operation of laboratories is not covered by this International Standard.

1.6 If testing and calibration laboratories comply with the requirements of this International Standard, they will operate a quality management system for their testing and calibration activities that also meets the principles of ISO 9001. Annex A provides nominal cross-references between this International Standard and ISO 9001. This International Standard covers technical competence requirements that are not covered by ISO 9001.

NOTE 1 It might be necessary to explain or interpret certain requirements in this International Standard to ensure that the requirements are applied in a consistent manner. Guidance for establishing applications for specific fields, especially for accreditation bodies (see ISO/IEC 17011) is given in Annex B.

NOTE 2 If a laboratory wishes accreditation for part or all of its testing and calibration activities, it should select an accreditation body that operates in accordance with ISO/IEC 17011.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 17000, *Conformity assessment — Vocabulary and general principles*

VIM, *International vocabulary of basic and general terms in metrology*, issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML

NOTE Further related standards, guides, etc. on subjects included in this International Standard are given in the Bibliography.

3 Terms and definitions

For the purposes of this document, the relevant terms and definitions given in ISO/IEC 17000 and VIM apply.

NOTE General definitions related to quality are given in ISO 9000, whereas ISO/IEC 17000 gives definitions specifically related to certification and laboratory accreditation. Where different definitions are given in ISO 9000, the definitions in ISO/IEC 17000 and VIM are preferred.

4 Management requirements

4.1 Organization

4.1.1 The laboratory or the organization of which it is part shall be an entity that can be held legally responsible.

4.1.2 It is the responsibility of the laboratory to carry out its testing and calibration activities in such a way as to meet the requirements of this International Standard and to satisfy the needs of the customer, the regulatory authorities or organizations providing recognition.

4.1.3 The management system shall cover work carried out in the laboratory's permanent facilities, at sites away from its permanent facilities, or in associated temporary or mobile facilities.

4.1.4 If the laboratory is part of an organization performing activities other than testing and/or calibration, the responsibilities of key personnel in the organization that have an involvement or influence on the testing and/or calibration activities of the laboratory shall be defined in order to identify potential conflicts of interest.

NOTE 1 Where a laboratory is part of a larger organization, the organizational arrangements should be such that departments having conflicting interests, such as production, commercial marketing or financing do not adversely influence the laboratory's compliance with the requirements of this International Standard.

NOTE 2 If the laboratory wishes to be recognized as a third-party laboratory, it should be able to demonstrate that it is impartial and that it and its personnel are free from any undue commercial, financial and other pressures which might influence their technical judgement. The third-party testing or calibration laboratory should not engage in any activities that may endanger the trust in its independence of judgement and integrity in relation to its testing or calibration activities.

4.1.5 The laboratory shall

a) have managerial and technical personnel who, irrespective of other responsibilities, have the authority and resources needed to carry out their duties, including the implementation, maintenance and improvement of the management system, and to identify the occurrence of departures from the management system or from the procedures for performing tests and/or calibrations, and to initiate actions to prevent or minimize such departures (see also 5.2);

b) have arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work;

c) have policies and procedures to ensure the protection of its customers' confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results;

d) have policies and procedures to avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgement or operational integrity;

e) define the organization and management structure of the laboratory, its place in any parent organization, and the relationships between quality management, technical operations and support services;

f) specify the responsibility, authority and interrelationships of all personnel who manage, perform or verify work affecting the quality of the tests and/or calibrations;

g) provide adequate supervision of testing and calibration staff, including trainees, by persons familiar with methods and procedures, purpose of each test and/or calibration, and with the assessment of the test or calibration results;

h) have technical management which has overall responsibility for the technical operations and the provision of the resources needed to ensure the required quality of laboratory operations;

i) appoint a member of staff as quality manager (however named) who, irrespective of other duties and responsibilities, shall have defined responsibility and authority for ensuring that the management system related to quality is implemented and followed at all times; the quality manager shall have direct access to the highest level of management at which decisions are made on laboratory policy or resources;

j) appoint deputies for key managerial personnel (see Note);

k) ensure that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system.

NOTE Individuals may have more than one function and it may be impractical to appoint deputies for every function.

4.1.6 Top management shall ensure that appropriate communication processes are established within the laboratory and that communication takes place regarding the effectiveness of the management system.

4.2 Management system

4.2.1 The laboratory shall establish, implement and maintain a management system appropriate to the scope of its activities. The laboratory shall document its policies, systems, programmes, procedures and instructions to the extent necessary to assure the quality of the test and/or calibration results. The system's documentation shall be communicated to, understood by, available to, and implemented by the appropriate personnel.

4.2.2 The laboratory's management system policies related to quality, including a quality policy statement, shall be defined in a quality manual (however named). The overall objectives shall be established, and shall be reviewed during management review. The quality policy statement shall be issued under the authority of top management. It shall include at least the following:

a) the laboratory management's commitment to good professional practice and to the quality of its testing and calibration in servicing its customers;

b) the management's statement of the laboratory's standard of service;

c) the purpose of the management system related to quality;

d) a requirement that all personnel concerned with testing and calibration activities within the laboratory familiarize themselves with the quality documentation and implement the policies and procedures in their work; and

e) the laboratory management's commitment to comply with this International Standard and to continually improve the effectiveness of the management system.

NOTE The quality policy statement should be concise and may include the requirement that tests and/or calibrations shall always be carried out in accordance with stated methods and customers' requirements. When the test and/or calibration laboratory is part of a larger organization, some quality policy elements may be in other documents.

4.2.3 Top management shall provide evidence of commitment to the development and implementation of the management system and to continually improving its effectiveness.

4.2.4 Top management shall communicate to the organization the importance of meeting customer requirements as well as statutory and regulatory requirements.

4.2.5 The quality manual shall include or make reference to the supporting procedures including technical procedures. It shall outline the structure of the documentation used in the management system.

4.2.6 The roles and responsibilities of technical management and the quality manager, including their responsibility for ensuring compliance with this International Standard, shall be defined in the quality manual.

4.2.7 Top management shall ensure that the integrity of the management system is maintained when changes to the management system are planned and implemented.

4.3 Document control

4.3.1 General

The laboratory shall establish and maintain procedures to control all documents that form part of its management system (internally generated or from external sources), such as regulations, standards, other normative documents, test and/or calibration methods, as well as drawings, software, specifications, instructions and manuals.

NOTE 1 In this context "document" could be policy statements, procedures, specifications, calibration tables, charts, text books, posters, notices, memoranda, software, drawings, plans, etc. These may be on various media, whether hard copy or electronic, and they may be digital, analog, photographic or written.

NOTE 2 The control of data related to testing and calibration is covered in 5.4.7. The control of records is covered in 4.13.

4.3.2 Document approval and issue

4.3.2.1 All documents issued to personnel in the laboratory as part of the management system shall be reviewed and approved for use by authorized personnel prior to issue. A master list or an equivalent document control procedure identifying the current revision status and distribution of documents in the management system shall be established and shall be readily available to preclude the use of invalid and/or obsolete documents.

4.3.2.2 The procedure(s) adopted shall ensure that:

a) authorized editions of appropriate documents are available at all locations where operations essential to the effective functioning of the laboratory are performed;

b) documents are periodically reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements;

c) invalid or obsolete documents are promptly removed from all points of issue or use, or otherwise assured against unintended use;

d) obsolete documents retained for either legal or knowledge preservation purposes are suitably marked.

4.3.2.3 Management system documents generated by the laboratory shall be uniquely identified. Such identification shall include the date of issue and/or revision identification, page numbering, the total number of pages or a mark to signify the end of the document, and the issuing authority(ies).

4.3.3 Document changes

4.3.3.1 Changes to documents shall be reviewed and approved by the same function that performed the original review unless specifically designated otherwise. The designated personnel shall have access to pertinent background information upon which to base their review and approval.

4.3.3.2 Where practicable, the altered or new text shall be identified in the document or the appropriate attachments.

4.3.3.3 If the laboratory's document control system allows for the amendment of documents by hand pending the re-issue of the documents, the procedures and authorities for such amendments shall be defined. Amendments shall be clearly marked, initialled and dated. A revised document shall be formally re-issued as soon as practicable.

4.3.3.4 Procedures shall be established to describe how changes in documents maintained in computerized systems are made and controlled.

4.4 Review of requests, tenders and contracts

4.4.1 The laboratory shall establish and maintain procedures for the review of requests, tenders and contracts. The policies and procedures for these reviews leading to a contract for testing and/or calibration shall ensure that:

a) the requirements, including the methods to be used, are adequately defined, documented and understood (see 5.4.2);

b) the laboratory has the capability and resources to meet the requirements;

c) the appropriate test and/or calibration method is selected and is capable of meeting the customers' requirements (see 5.4.2).

Any differences between the request or tender and the contract shall be resolved before any work commences. Each contract shall be acceptable both to the laboratory and the customer.

NOTE 1 The request, tender and contract review should be conducted in a practical and efficient manner, and the effect of financial, legal and time schedule aspects should be taken into account. For internal customers, reviews of requests, tenders and contracts can be performed in a simplified way.

NOTE 2 The review of capability should establish that the laboratory possesses the necessary physical, personnel and information resources, and that the laboratory's personnel have the skills and expertise necessary for the performance of the tests and/or calibrations in question. The review may also encompass results of earlier participation in interlaboratory comparisons or proficiency testing and/or the running of trial test or calibration programmes using samples or items of known value in order to determine uncertainties of measurement, limits of detection, confidence limits, etc.

NOTE 3 A contract may be any written or oral agreement to provide a customer with testing and/or calibration services.

4.4.2 Records of reviews, including any significant changes, shall be maintained. Records shall also be maintained of pertinent discussions with a customer relating to the customer's requirements or the results of the work during the period of execution of the contract.

NOTE For review of routine and other simple tasks, the date and the identification (e.g. the initials) of the person in the laboratory responsible for carrying out the contracted work are considered adequate. For repetitive routine tasks, the review need be made only at the initial enquiry stage or on granting of the contract for on-going routine work performed under a general agreement with the customer, provided that the customer's requirements remain unchanged. For new, complex or advanced testing and/or calibration tasks, a more comprehensive record should be maintained.

4.4.3 The review shall also cover any work that is subcontracted by the laboratory.

4.4.4 The customer shall be informed of any deviation from the contract.

4.4.5 If a contract needs to be amended after work has commenced, the same contract review process shall be repeated and any amendments shall be communicated to all affected personnel.

4.5 Subcontracting of tests and calibrations

4.5.1 When a laboratory subcontracts work, whether because of unforeseen reasons (e.g. workload, need for further expertise or temporary incapacity) or on a continuing basis (e.g. through permanent subcontracting, agency or franchising arrangements), this work shall be placed with a competent subcontractor. A competent subcontractor is one that, for example, complies with this International Standard for the work in question.

4.5.2 The laboratory shall advise the customer of the arrangement in writing and, when appropriate, gain the approval of the customer, preferably in writing.

4.5.3 The laboratory is responsible to the customer for the subcontractor's work, except in the case where the customer or a regulatory authority specifies which subcontractor is to be used.

4.5.4 The laboratory shall maintain a register of all subcontractors that it uses for tests and/or calibrations and a record of the evidence of compliance with this International Standard for the work in question.

4.6 Purchasing services and supplies

4.6.1 The laboratory shall have a policy and procedure(s) for the selection and purchasing of services and supplies it uses that affect the quality of the tests and/or calibrations. Procedures shall exist for the purchase, reception and storage of reagents and laboratory consumable materials relevant for the tests and calibrations.

4.6.2 The laboratory shall ensure that purchased supplies and reagents and consumable materials that affect the quality of tests and/or calibrations are not used until they have been inspected or otherwise verified as complying with standard specifications or requirements defined in the methods for the tests and/or calibrations concerned. These services and supplies used shall comply with specified requirements. Records of actions taken to check compliance shall be maintained.

4.6.3 Purchasing documents for items affecting the quality of laboratory output shall contain data describing the services and supplies ordered. These purchasing documents shall be reviewed and approved for technical content prior to release.

NOTE The description may include type, class, grade, precise identification, specifications, drawings, inspection instructions, other technical data including approval of test results, the quality required and the management system standard under which they were made.

4.6.4 The laboratory shall evaluate suppliers of critical consumables, supplies and services which affect the quality of testing and calibration, and shall maintain records of these evaluations and list those approved.

4.7 Service to the customer

4.7.1 The laboratory shall be willing to cooperate with customers or their representatives in clarifying the customer's request and in monitoring the laboratory's performance in relation to the work performed, provided that the laboratory ensures confidentiality to other customers.

NOTE 1 Such cooperation may include:

a) providing the customer or the customer's representative reasonable access to relevant areas of the laboratory for the witnessing of tests and/or calibrations performed for the customer;

b) preparation, packaging, and dispatch of test and/or calibration items needed by the customer for verification purposes.

NOTE 2 Customers value the maintenance of good communication, advice and guidance in technical matters, and opinions and interpretations based on results. Communication with the customer, especially in large assignments, should be maintained throughout the work. The laboratory should inform the customer of any delays or major deviations in the performance of the tests and/or calibrations.

4.7.2 The laboratory shall seek feedback, both positive and negative, from its customers. The feedback shall be used and analysed to improve the management system, testing and calibration activities and customer service.

NOTE Examples of the types of feedback include customer satisfaction surveys and review of test or calibration reports with customers.

4.8 Complaints

The laboratory shall have a policy and procedure for the resolution of complaints received from customers or other parties. Records shall be maintained of all complaints and of the investigations and corrective actions taken by the laboratory (see also 4.11).

4.9 Control of nonconforming testing and/or calibration work

4.9.1 The laboratory shall have a policy and procedures that shall be implemented when any aspect of its testing and/or calibration work, or the results of this work, do not conform to its own procedures or the agreed requirements of the customer. The policy and procedures shall ensure that:

a) the responsibilities and authorities for the management of nonconforming work are designated and actions (including halting of work and withholding of test reports and calibration certificates, as necessary) are defined and taken when nonconforming work is identified;

b) an evaluation of the significance of the nonconforming work is made;

c) correction is taken immediately, together with any decision about the acceptability of the nonconforming work;

d) where necessary, the customer is notified and work is recalled;

e) the responsibility for authorizing the resumption of work is defined.

NOTE Identification of nonconforming work or problems with the management system or with testing and/or calibration activities can occur at various places within the management system and technical operations. Examples are customer complaints, quality control, instrument calibration, checking of consumable materials, staff observations or supervision, test report and calibration certificate checking, management reviews and internal or external audits.

4.9.2 Where the evaluation indicates that the nonconforming work could recur or that there is doubt about the compliance of the laboratory's operations with its own policies and procedures, the corrective action procedures given in 4.11 shall be promptly followed.

4.10 Improvement

The laboratory shall continually improve the effectiveness of its management system through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review.

4.11 Corrective action

4.11.1 General

The laboratory shall establish a policy and a procedure and shall designate appropriate authorities for implementing corrective action when nonconforming work or departures from the policies and procedures in the management system or technical operations have been identified.

NOTE A problem with the management system or with the technical operations of the laboratory may be identified through a variety of activities, such as control of nonconforming work, internal or external audits, management reviews, feedback from customers and from staff observations.

4.11.2 Cause analysis

The procedure for corrective action shall start with an investigation to determine the root cause(s) of the problem.

NOTE Cause analysis is the key and sometimes the most difficult part in the corrective action procedure. Often the root cause is not obvious and thus a careful analysis of all potential causes of the problem is required. Potential causes could include customer requirements, the samples, sample specifications, methods and procedures, staff skills and training, consumables, or equipment and its calibration.

4.11.3 Selection and implementation of corrective actions

Where corrective action is needed, the laboratory shall identify potential corrective actions. It shall select and implement the action(s) most likely to eliminate the problem and to prevent recurrence.

Corrective actions shall be to a degree appropriate to the magnitude and the risk of the problem.

The laboratory shall document and implement any required changes resulting from corrective action investigations.

4.11.4 Monitoring of corrective actions

The laboratory shall monitor the results to ensure that the corrective actions taken have been effective.

4.11.5 Additional audits

Where the identification of nonconformities or departures casts doubts on the laboratory's compliance with its own policies and procedures, or on its compliance with this International Standard, the laboratory shall ensure that the appropriate areas of activity are audited in accordance with 4.14 as soon as possible.

NOTE Such additional audits often follow the implementation of the corrective actions to confirm their effectiveness. An additional audit should be necessary only when a serious issue or risk to the business is identified.

4.12 Preventive action

4.12.1 Needed improvements and potential sources of nonconformities, either technical or concerning the management system, shall be identified. When improvement opportunities are identified or if preventive action is required, action plans shall be developed, implemented and monitored to reduce the likelihood of the occurrence of such nonconformities and to take advantage of the opportunities for improvement.

4.12.2 Procedures for preventive actions shall include the initiation of such actions and the application of controls to ensure that they are effective.

NOTE 1 Preventive action is a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints.

NOTE 2 Apart from the review of the operational procedures, the preventive action might involve analysis of data, including trend and risk analyses and proficiency-testing results.

4.13 Control of records

4.13.1 General

4.13.1.1 The laboratory shall establish and maintain procedures for identification, collection, indexing, access, filing, storage, maintenance and disposal of quality and technical records. Quality records shall include reports from internal audits and management reviews as well as records of corrective and preventive actions.

4.13.1.2 All records shall be legible and shall be stored and retained in such a way that they are readily retrievable in facilities that provide a suitable environment to prevent damage or deterioration and to prevent loss. Retention times of records shall be established.

NOTE Records may be in any media, such as hard copy or electronic media.

4.13.1.3 All records shall be held secure and in confidence.

4.13.1.4 The laboratory shall have procedures to protect and back-up records stored electronically and to prevent unauthorized access to or amendment of these records.

4.13.2 Technical records

4.13.2.1 The laboratory shall retain records of original observations, derived data and sufficient information to establish an audit trail, calibration records, staff records and a copy of each test report or calibration certificate issued, for a defined period. The records for each test or calibration shall contain sufficient information to facilitate, if possible, identification of factors affecting the uncertainty and to enable the test or calibration to be repeated under conditions as close as possible to the original. The records shall include the identity of personnel responsible for the sampling, performance of each test and/or calibration and checking of results.

NOTE 1 In certain fields it may be impossible or impractical to retain records of all original observations.

NOTE 2 Technical records are accumulations of data (see 5.4.7) and information which result from carrying out tests and/or calibrations and which indicate whether specified quality or process parameters are achieved. They may include forms, contracts, work sheets, work books, check sheets, work notes, control graphs, external and internal test reports and calibration certificates, customers' notes, papers and feedback.

4.13.2.2 Observations, data and calculations shall be recorded at the time they are made and shall be identifiable to the specific task.

4.13.2.3 When mistakes occur in records, each mistake shall be crossed out, not erased, made illegible or deleted, and the correct value entered alongside. All such alterations to records shall be signed or initialled by the person making the correction. In the case of records stored electronically, equivalent measures shall be taken to avoid loss or change of original data.

4.14 Internal audits

4.14.1 The laboratory shall periodically, and in accordance with a predetermined schedule and procedure, conduct internal audits of its activities to verify that its operations continue to comply with the requirements of the management system and this International Standard. The internal audit programme shall address all elements of the management system, including the testing and/or calibration activities. It is the responsibility of the quality manager to plan and organize audits as required by the schedule and requested by management. Such audits shall be carried out by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

NOTE The cycle for internal auditing should normally be completed in one year.

4.14.2 When audit findings cast doubt on the effectiveness of the operations or on the correctness or validity of the laboratory's test or calibration results, the laboratory shall take timely corrective action, and shall notify customers in writing if investigations show that the laboratory results may have been affected.

4.14.3 The area of activity audited, the audit findings and corrective actions that arise from them shall be recorded.

4.14.4 Follow-up audit activities shall verify and record the implementation and effectiveness of the corrective action taken.

4.15 Management reviews

4.15.1 In accordance with a predetermined schedule and procedure, the laboratory's top management shall periodically conduct a review of the laboratory's management system and testing and/or calibration activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review shall take account of:

— the suitability of policies and procedures;

— reports from managerial and supervisory personnel;

— the outcome of recent internal audits;

— corrective and preventive actions;

— assessments by external bodies;

— the results of interlaboratory comparisons or proficiency tests;

— changes in the volume and type of the work;

— customer feedback;

— complaints;

— recommendations for improvement;

— other relevant factors, such as quality control activities, resources and staff training.

NOTE 1 A typical period for conducting a management review is once every 12 months.

NOTE 2 Results should feed into the laboratory planning system and should include the goals, objectives and action plans for the coming year.

NOTE 3 A management review includes consideration of related subjects at regular management meetings.

4.15.2 Findings from management reviews and the actions that arise from them shall be recorded. The management shall ensure that those actions are carried out within an appropriate and agreed timescale.

5 Technical requirements

5.1 General

5.1.1 Many factors determine the correctness and reliability of the tests and/or calibrations performed by a laboratory. These factors include contributions from:

— human factors (5.2);

— accommodation and environmental conditions (5.3);

— test and calibration methods and method validation (5.4);

— equipment (5.5);

— measurement traceability (5.6);

— sampling (5.7);

— the handling of test and calibration items (5.8).

5.1.2 The extent to which the factors contribute to the total uncertainty of measurement differs considerably between (types of) tests and between (types of) calibrations. The laboratory shall take account of these factors in developing test and calibration methods and procedures, in the training and qualification of personnel, and in the selection and calibration of the equipment it uses.

5.2 Personnel

5.2.1 The laboratory management shall ensure the competence of all who operate specific equipment, perform tests and/or calibrations, evaluate results, and sign test reports and calibration certificates. When using staff who are undergoing training, appropriate supervision shall be provided. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and/or demonstrated skills, as required.

NOTE 1 In some technical areas (e.g. non-destructive testing) it may be required that the personnel performing certain tasks hold personnel certification. The laboratory is responsible for fulfilling specified personnel certification requirements. The requirements for personnel certification might be regulatory, included in the standards for the specific technical field, or required by the customer.

NOTE 2 The personnel responsible for the opinions and interpretation included in test reports should, in addition to the appropriate qualifications, training, experience and satisfactory knowledge of the testing carried out, also have:

— relevant knowledge of the technology used for the manufacturing of the items, materials, products, etc. tested, or the way they are used or intended to be used, and of the defects or degradations which may occur during or in service;

— knowledge of the general requirements expressed in the legislation and standards; and

— an understanding of the significance of deviations found with regard to the normal use of the items, materials, products, etc. concerned.

5.2.2 The management of the laboratory shall formulate the goals with respect to the education, training and skills of the laboratory personnel. The laboratory shall have a policy and procedures for identifying training needs and providing training of personnel. The training programme shall be relevant to the present and anticipated tasks of the laboratory. The effectiveness of the training actions taken shall be evaluated.

5.2.3 The laboratory shall use personnel who are employed by, or under contract to, the laboratory. Where contracted and additional technical and key support personnel are used, the laboratory shall ensure that such personnel are supervised and competent and that they work in accordance with the laboratory's management system.

5.2.4 The laboratory shall maintain current job descriptions for managerial, technical and key support personnel involved in tests and/or calibrations.

NOTE Job descriptions can be defined in many ways. As a minimum, the following should be defined:

— the responsibilities with respect to performing tests and/or calibrations;

— the responsibilities with respect to the planning of tests and/or calibrations and evaluation of results;

— the responsibilities for reporting opinions and interpretations;

— the responsibilities with respect to method modification and development and validation of new methods;

— expertise and experience required;

— qualifications and training programmes;

— managerial duties.

5.2.5 The management shall authorize specific personnel to perform particular types of sampling, test and/or calibration, to issue test reports and calibration certificates, to give opinions and interpretations and to operate particular types of equipment. The laboratory shall maintain records of the relevant authorization(s), competence, educational and professional qualifications, training, skills and experience of all technical personnel, including contracted personnel. This information shall be readily available and shall include the date on which authorization and/or competence is confirmed.

5.3 Accommodation and environmental conditions

5.3.1 Laboratory facilities for testing and/or calibration, including but not limited to energy sources, lighting and environmental conditions, shall be such as to facilitate correct performance of the tests and/or calibrations.

The laboratory shall ensure that the environmental conditions do not invalidate the results or adversely affect the required quality of any measurement. Particular care shall be taken when sampling and tests and/or calibrations are undertaken at sites other than a permanent laboratory facility. The technical requirements for accommodation and environmental conditions that can affect the results of tests and calibrations shall be documented.

5.3.2 The laboratory shall monitor, control and record environmental conditions as required by the relevant specifications, methods and procedures or where they influence the quality of the results. Due attention shall be paid, for example, to biological sterility, dust, electromagnetic disturbances, radiation, humidity, electrical supply, temperature, and sound and vibration levels, as appropriate to the technical activities concerned. Tests and calibrations shall be stopped when the environmental conditions jeopardize the results of the tests and/or calibrations.

5.3.3 There shall be effective separation between neighbouring areas in which there are incompatible activities. Measures shall be taken to prevent cross-contamination.

5.3.4 Access to and use of areas affecting the quality of the tests and/or calibrations shall be controlled. The laboratory shall determine the extent of control based on its particular circumstances.

5.3.5 Measures shall be taken to ensure good housekeeping in the laboratory. Special procedures shall be prepared where necessary.

5.4 Test and calibration methods and method validation

5.4.1 General

The laboratory shall use appropriate methods and procedures for all tests and/or calibrations within its scope. These include sampling, handling, transport, storage and preparation of items to be tested and/or calibrated, and, where appropriate, an estimation of the measurement uncertainty as well as statistical techniques for analysis of test and/or calibration data.

The laboratory shall have instructions on the use and operation of all relevant equipment, and on the handling and preparation of items for testing and/or calibration, or both, where the absence of such instructions could jeopardize the results of tests and/or calibrations. All instructions, standards, manuals and reference data relevant to the work of the laboratory shall be kept up to date and shall be made readily available to personnel (see 4.3). Deviation from test and calibration methods shall occur only if the deviation has been documented, technically justified, authorized, and accepted by the customer.

NOTE International, regional or national standards or other recognized specifications that contain sufficient and concise information on how to perform the tests and/or calibrations do not need to be supplemented or rewritten as internal procedures if these standards are written in a way that they can be used as published by the operating staff in a laboratory. It may be necessary to provide additional documentation for optional steps in the method or additional details.

5.4.2 Selection of methods

The laboratory shall use test and/or calibration methods, including methods for sampling, which meet the needs of the customer and which are appropriate for the tests and/or calibrations it undertakes. Methods published in international, regional or national standards shall preferably be used. The laboratory shall ensure that it uses the latest valid edition of a standard unless it is not appropriate or possible to do so. When necessary, the standard shall be supplemented with additional details to ensure consistent application.

When the customer does not specify the method to be used, the laboratory shall select appropriate methods that have been published either in international, regional or national standards, or by reputable technical organizations, or in relevant scientific texts or journals, or as specified by the manufacturer of the equipment. Laboratory-developed methods or methods adopted by the laboratory may also be used if they are appropriate for the intended use and if they are validated. The customer shall be informed as to the method chosen. The laboratory shall confirm that it can properly operate standard methods before introducing the tests or calibrations. If the standard method changes, the confirmation shall be repeated.

The laboratory shall inform the customer when the method proposed by the customer is considered to be inappropriate or out of date.

5.4.3 Laboratory-developed methods

The introduction of test and calibration methods developed by the laboratory for its own use shall be a planned activity and shall be assigned to qualified personnel equipped with adequate resources.

Plans shall be updated as development proceeds and effective communication amongst all personnel involved shall be ensured.

5.4.4 Non-standard methods

When it is necessary to use methods not covered by standard methods, these shall be subject to agreement with the customer and shall include a clear specification of the customer's requirements and the purpose of the test and/or calibration. The method developed shall have been validated appropriately before use.

NOTE For new test and/or calibration methods, procedures should be developed prior to the tests and/or calibrations being performed and should contain at least the following information:

a) appropriate identification;

b) scope;

c) description of the type of item to be tested or calibrated;

d) parameters or quantities and ranges to be determined;

e) apparatus and equipment, including technical performance requirements;

f) reference standards and reference materials required;

g) environmental conditions required and any stabilization period needed;

h) description of the procedure, including

- affixing of identification marks, handling, transporting, storing and preparation of items,
- checks to be made before the work is started,
- checks that the equipment is working properly and, where required, calibration and adjustment of the equipment before each use,
- the method of recording the observations and results,
- any safety measures to be observed;

i) criteria and/or requirements for approval/rejection;

j) data to be recorded and method of analysis and presentation;

k) the uncertainty or the procedure for estimating uncertainty.

5.4.5 Validation of methods

5.4.5.1 Validation is the confirmation by examination and the provision of objective evidence that the particular requirements for a specific intended use are fulfilled.

5.4.5.2 The laboratory shall validate non-standard methods, laboratory-designed/developed methods, standard methods used outside their intended scope, and amplifications and modifications of standard methods to confirm that the methods are fit for the intended use. The validation shall be as extensive as is necessary to meet the needs of the given application or field of application. The laboratory shall record the results obtained, the procedure used for the validation, and a statement as to whether the method is fit for the intended use.

NOTE 1 Validation may include procedures for sampling, handling and transportation.

NOTE 2 The techniques used for the determination of the performance of a method should be one of, or a combination of, the following:

— calibration using reference standards or reference materials;

— comparison of results achieved with other methods;

— interlaboratory comparisons;

— systematic assessment of the factors influencing the result;

— assessment of the uncertainty of the results based on scientific understanding of the theoretical principles of the method and practical experience.

NOTE 3 When some changes are made in the validated non-standard methods, the influence of such changes should be documented and, if appropriate, a new validation should be carried out.

5.4.5.3 The range and accuracy of the values obtainable from validated methods (e.g. the uncertainty of the results, detection limit, selectivity of the method, linearity, limit of repeatability and/or reproducibility, robustness against external influences and/or cross-sensitivity against interference from the matrix of the sample/test object), as assessed for the intended use, shall be relevant to the customers' needs.

NOTE 1 Validation includes specification of the requirements, determination of the characteristics of the methods, a check that the requirements can be fulfilled by using the method, and a statement on the validity.

NOTE 2 As method-development proceeds, regular review should be carried out to verify that the needs of the customer are still being fulfilled. Any change in requirements requiring modifications to the development plan should be approved and authorized.

NOTE 3 Validation is always a balance between costs, risks and technical possibilities. There are many cases in which the range and uncertainty of the values (e.g. accuracy, detection limit, selectivity, linearity, repeatability, reproducibility, robustness and cross-sensitivity) can only be given in a simplified way due to lack of information.

5.4.6 Estimation of uncertainty of measurement

5.4.6.1 A calibration laboratory, or a testing laboratory performing its own calibrations, shall have and shall apply a procedure to estimate the uncertainty of measurement for all calibrations and types of calibrations.

5.4.6.2 Testing laboratories shall have and shall apply procedures for estimating uncertainty of measurement. In certain cases the nature of the test method may preclude rigorous, metrologically and statistically valid, calculation of uncertainty of measurement. In these cases the laboratory shall at least attempt to identify all the components of uncertainty and make a reasonable estimation, and shall ensure that the form of reporting of the result does not give a wrong impression of the uncertainty. Reasonable estimation shall be based on knowledge of the performance of the method and on the measurement scope and shall make use of, for example, previous experience and validation data.

NOTE 1 The degree of rigor needed in an estimation of uncertainty of measurement depends on factors such as:

— the requirements of the test method;

— the requirements of the customer;

— the existence of narrow limits on which decisions on conformity to a specification are based.

NOTE 2 In those cases where a well-recognized test method specifies limits to the values of the major sources of uncertainty of measurement and specifies the form of presentation of calculated results, the laboratory is considered to have satisfied this clause by following the test method and reporting instructions (see 5.10).

5.4.6.3 When estimating the uncertainty of measurement, all uncertainty components which are of importance in the given situation shall be taken into account using appropriate methods of analysis.

NOTE 1 Sources contributing to the uncertainty include, but are not necessarily limited to, the reference standards and reference materials used, methods and equipment used, environmental conditions, properties and condition of the item being tested or calibrated, and the operator.

NOTE 2 The predicted long-term behaviour of the tested and/or calibrated item is not normally taken into account when estimating the measurement uncertainty.

NOTE 3 For further information, see ISO 5725 and the Guide to the Expression of Uncertainty in Measurement (see Bibliography).

5.4.7 Control of data

5.4.7.1 Calculations and data transfers shall be subject to appropriate checks in a systematic manner.

5.4.7.2 When computers or automated equipment are used for the acquisition, processing, recording, reporting, storage or retrieval of test or calibration data, the laboratory shall ensure that:

a) computer software developed by the user is documented in sufficient detail and is suitably validated as being adequate for use;

b) procedures are established and implemented for protecting the data; such procedures shall include, but not be limited to, integrity and confidentiality of data entry or collection, data storage, data transmission and data processing;

c) computers and automated equipment are maintained to ensure proper functioning and are provided with the environmental and operating conditions necessary to maintain the integrity of test and calibration data.

NOTE Commercial off-the-shelf software (e.g. wordprocessing, database and statistical programmes) in general use within their designed application range may be considered to be sufficiently validated. However, laboratory software configuration/modifications should be validated as in 5.4.7.2 a).

5.5 Equipment

5.5.1 The laboratory shall be furnished with all items of sampling, measurement and test equipment required for the correct performance of the tests and/or calibrations (including sampling, preparation of test and/or calibration items, processing and analysis of test and/or calibration data). In those cases where the laboratory needs to use equipment outside its permanent control, it shall ensure that the requirements of this International Standard are met.

5.5.2 Equipment and its software used for testing, calibration and sampling shall be capable of achieving the accuracy required and shall comply with specifications relevant to the tests and/or calibrations concerned. Calibration programmes shall be established for key quantities or values of the instruments where these properties have a significant effect on the results. Before being placed into service, equipment (including that used for sampling) shall be calibrated or checked to establish that it meets the laboratory's specification requirements and complies with the relevant standard specifications. It shall be checked and/or calibrated before use (see 5.6).

5.5.3 Equipment shall be operated by authorized personnel. Up-to-date instructions on the use and maintenance of equipment (including any relevant manuals provided by the manufacturer of the equipment) shall be readily available for use by the appropriate laboratory personnel.

5.5.4 Each item of equipment and its software used for testing and calibration and significant to the result shall, when practicable, be uniquely identified.

5.5.5 Records shall be maintained of each item of equipment and its software significant to the tests and/or calibrations performed. The records shall include at least the following:

a) the identity of the item of equipment and its software;

b) the manufacturer's name, type identification, and serial number or other unique identification;

c) checks that equipment complies with the specification (see 5.5.2);

d) the current location, where appropriate;

e) the manufacturer's instructions, if available, or reference to their location;

f) dates, results and copies of reports and certificates of all calibrations, adjustments, acceptance criteria, and the due date of next calibration;

g) the maintenance plan, where appropriate, and maintenance carried out to date;

h) any damage, malfunction, modification or repair to the equipment.

5.5.6 The laboratory shall have procedures for safe handling, transport, storage, use and planned maintenance of measuring equipment to ensure proper functioning and in order to prevent contamination or deterioration.

NOTE Additional procedures may be necessary when measuring equipment is used outside the permanent laboratory for tests, calibrations or sampling.

5.5.7 Equipment that has been subjected to overloading or mishandling, gives suspect results, or has been shown to be defective or outside specified limits, shall be taken out of service. It shall be isolated to prevent its use or clearly labelled or marked as being out of service until it has been repaired and shown by calibration or test to perform correctly. The laboratory shall examine the effect of the defect or departure from specified limits on previous tests and/or calibrations and shall institute the "Control of nonconforming work" procedure (see 4.9).

5.5.8 Whenever practicable, all equipment under the control of the laboratory and requiring calibration shall be labelled, coded or otherwise identified to indicate the status of calibration, including the date when last calibrated and the date or expiration criteria when recalibration is due.

5.5.9 When, for whatever reason, equipment goes outside the direct control of the laboratory, the laboratory shall ensure that the function and calibration status of the equipment are checked and shown to be satisfactory before the equipment is returned to service.

5.5.10 When intermediate checks are needed to maintain confidence in the calibration status of the equipment, these checks shall be carried out according to a defined procedure.

5.5.11 Where calibrations give rise to a set of correction factors, the laboratory shall have procedures to ensure that copies (e.g. in computer software) are correctly updated.

5.5.12 Test and calibration equipment, including both hardware and software, shall be safeguarded from adjustments which would invalidate the test and/or calibration results.

5.6 Measurement traceability

5.6.1 General

All equipment used for tests and/or calibrations, including equipment for subsidiary measurements (e.g. for environmental conditions) having a significant effect on the accuracy or validity of the result of the test, calibration or sampling shall be calibrated before being put into service. The laboratory shall have an established programme and procedure for the calibration of its equipment.

NOTE Such a programme should include a system for selecting, using, calibrating, checking, controlling and maintaining measurement standards, reference materials used as measurement standards, and measuring and test equipment used to perform tests and calibrations.

5.6.2 Specific requirements

5.6.2.1 Calibration

5.6.2.1.1 For calibration laboratories, the programme for calibration of equipment shall be designed and operated so as to ensure that calibrations and measurements made by the laboratory are traceable to the International System of Units (SI) (*Système international d'unités*).

A calibration laboratory establishes traceability of its own measurement standards and measuring instruments to the SI by means of an unbroken chain of calibrations or comparisons linking them to relevant primary standards of the SI units of measurement. The link to SI units may be achieved by reference to national measurement standards. National measurement standards may be primary standards, which are primary realizations of the SI units or agreed representations of SI units based on fundamental physical constants, or they may be secondary standards which are standards calibrated by another national metrology institute. When using external calibration services, traceability of measurement shall be assured by the use of calibration services from laboratories that can demonstrate competence, measurement capability and traceability. The calibration certificates issued by these laboratories shall contain the measurement results, including the measurement uncertainty and/or a statement of compliance with an identified metrological specification (see also 5.10.4.2).

NOTE 1 Calibration laboratories fulfilling the requirements of this International Standard are considered to be competent. A calibration certificate bearing an accreditation body logo from a calibration laboratory accredited to this International Standard, for the calibration concerned, is sufficient evidence of traceability of the calibration data reported.

NOTE 2 Traceability to SI units of measurement may be achieved by reference to an appropriate primary standard (see VIM:1993, 6.4) or by reference to a natural constant, the value of which in terms of the relevant SI unit is known and recommended by the General Conference of Weights and Measures (CGPM) and the International Committee for Weights and Measures (CIPM).

NOTE 3 Calibration laboratories that maintain their own primary standard or representation of SI units based on fundamental physical constants can claim traceability to the SI system only after these standards have been compared, directly or indirectly, with other similar standards of a national metrology institute.

NOTE 4 The term "identified metrological specification" means that it must be clear from the calibration certificate which specification the measurements have been compared with, by including the specification or by giving an unambiguous reference to the specification.

NOTE 5 When the terms "international standard" or "national standard" are used in connection with traceability, it is assumed that these standards fulfil the properties of primary standards for the realization of SI units.

NOTE 6 Traceability to national measurement standards does not necessarily require the use of the national metrology institute of the country in which the laboratory is located.

NOTE 7 If a calibration laboratory wishes or needs to obtain traceability from a national metrology institute other than in its own country, this laboratory should select a national metrology institute that actively participates in the activities of BIPM either directly or through regional groups.

NOTE 8 The unbroken chain of calibrations or comparisons may be achieved in several steps carried out by different laboratories that can demonstrate traceability.

5.6.2.1.2 There are certain calibrations that currently cannot be strictly made in SI units. In these cases calibration shall provide confidence in measurements by establishing traceability to appropriate measurement standards such as:

— the use of certified reference materials provided by a competent supplier to give a reliable physical or chemical characterization of a material;

— the use of specified methods and/or consensus standards that are clearly described and agreed by all parties concerned.

Participation in a suitable programme of interlaboratory comparisons is required where possible.

5.6.2.2 Testing

5.6.2.2.1 For testing laboratories, the requirements given in 5.6.2.1 apply for measuring and test equipment with measuring functions used, unless it has been established that the associated contribution from the calibration contributes little to the total uncertainty of the test result. When this situation arises, the laboratory shall ensure that the equipment used can provide the uncertainty of measurement needed.

NOTE The extent to which the requirements in 5.6.2.1 should be followed depends on the relative contribution of the calibration uncertainty to the total uncertainty. If calibration is the dominant factor, the requirements should be strictly followed.

5.6.2.2.2 Where traceability of measurements to SI units is not possible and/or not relevant, the same requirements for traceability to, for example, certified reference materials, agreed methods and/or consensus standards, are required as for calibration laboratories (see 5.6.2.1.2).

5.6.3 Reference standards and reference materials

5.6.3.1 Reference standards

The laboratory shall have a programme and procedure for the calibration of its reference standards. Reference standards shall be calibrated by a body that can provide traceability as described in 5.6.2.1. Such reference standards of measurement held by the laboratory shall be used for calibration only and for no other purpose, unless it can be shown that their performance as reference standards would not be invalidated. Reference standards shall be calibrated before and after any adjustment.

5.6.3.2 Reference materials

Reference materials shall, where possible, be traceable to SI units of measurement, or to certified reference materials. Internal reference materials shall be checked as far as is technically and economically practicable.

5.6.3.3 Intermediate checks

Checks needed to maintain confidence in the calibration status of reference, primary, transfer or working standards and reference materials shall be carried out according to defined procedures and schedules.

5.6.3.4 Transport and storage

The laboratory shall have procedures for safe handling, transport, storage and use of reference standards and reference materials in order to prevent contamination or deterioration and in order to protect their integrity.

NOTE Additional procedures may be necessary when reference standards and reference materials are used outside the permanent laboratory for tests, calibrations or sampling.

5.7 Sampling

5.7.1 The laboratory shall have a sampling plan and procedures for sampling when it carries out sampling of substances, materials or products for subsequent testing or calibration. The sampling plan as well as the sampling procedure shall be available at the location where sampling is undertaken. Sampling plans shall, whenever reasonable, be based on appropriate statistical methods. The sampling process shall address the factors to be controlled to ensure the validity of the test and calibration results.

NOTE 1 Sampling is a defined procedure whereby a part of a substance, material or product is taken to provide for testing or calibration of a representative sample of the whole. Sampling may also be required by the appropriate specification for which the substance, material or product is to be tested or calibrated. In certain cases (e.g. forensic analysis), the sample may not be representative but is determined by availability.

NOTE 2 Sampling procedures should describe the selection, sampling plan, withdrawal and preparation of a sample or samples from a substance, material or product to yield the required information.

5.7.2 Where the customer requires deviations, additions or exclusions from the documented sampling procedure, these shall be recorded in detail with the appropriate sampling data and shall be included in all documents containing test and/or calibration results, and shall be communicated to the appropriate personnel.

5.7.3 The laboratory shall have procedures for recording relevant data and operations relating to sampling that forms part of the testing or calibration that is undertaken. These records shall include the sampling procedure used, the identification of the sampler, environmental conditions (if relevant) and diagrams or other equivalent means to identify the sampling location as necessary and, if appropriate, the statistics the sampling procedures are based upon.

5.8 Handling of test and calibration items

5.8.1 The laboratory shall have procedures for the transportation, receipt, handling, protection, storage, retention and/or disposal of test and/or calibration items, including all provisions necessary to protect the integrity of the test or calibration item, and to protect the interests of the laboratory and the customer.

5.8.2 The laboratory shall have a system for identifying test and/or calibration items. The identification shall be retained throughout the life of the item in the laboratory. The system shall be designed and operated so as to ensure that items cannot be confused physically or when referred to in records or other documents. The system shall, if appropriate, accommodate a sub-division of groups of items and the transfer of items within and from the laboratory.

5.8.3 Upon receipt of the test or calibration item, abnormalities or departures from normal or specified conditions, as described in the test or calibration method, shall be recorded. When there is doubt as to the suitability of an item for test or calibration, or when an item does not conform to the description provided, or the test or calibration required is not specified in sufficient detail, the laboratory shall consult the customer for further instructions before proceeding and shall record the discussion.

5.8.4 The laboratory shall have procedures and appropriate facilities for avoiding deterioration, loss or damage to the test or calibration item during storage, handling and preparation. Handling instructions provided with the item shall be followed. When items have to be stored or conditioned under specified environmental conditions, these conditions shall be maintained, monitored and recorded. Where a test or calibration item or a portion of an item is to be held secure, the laboratory shall have arrangements for storage and security that protect the condition and integrity of the secured items or portions concerned.

NOTE 1 Where test items are to be returned into service after testing, special care is required to ensure that they are not damaged or injured during the handling, testing or storing/waiting processes.

NOTE 2 A sampling procedure and information on storage and transport of samples, including information on sampling factors influencing the test or calibration result, should be provided to those responsible for taking and transporting the samples.

NOTE 3 Reasons for keeping a test or calibration item secure can be for reasons of record, safety or value, or to enable complementary tests and/or calibrations to be performed later.

5.9 Assuring the quality of test and calibration results

5.9.1 The laboratory shall have quality control procedures for monitoring the validity of tests and calibrations undertaken. The resulting data shall be recorded in such a way that trends are detectable and, where practicable, statistical techniques shall be applied to the reviewing of the results. This monitoring shall be planned and reviewed and may include, but not be limited to, the following:

a) regular use of certified reference materials and/or internal quality control using secondary reference materials;

b) participation in interlaboratory comparison or proficiency-testing programmes;

c) replicate tests or calibrations using the same or different methods;

d) retesting or recalibration of retained items;

e) correlation of results for different characteristics of an item.

NOTE The selected methods should be appropriate for the type and volume of the work undertaken.

5.9.2 Quality control data shall be analysed and, where they are found to be outside pre-defined criteria, planned action shall be taken to correct the problem and to prevent incorrect results from being reported.

5.10 Reporting the results

5.10.1 General

The results of each test, calibration, or series of tests or calibrations carried out by the laboratory shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the test or calibration methods.

The results shall be reported, usually in a test report or a calibration certificate (see Note 1), and shall include all the information requested by the customer and necessary for the interpretation of the test or calibration results and all information required by the method used. This information is normally that required by 5.10.2, and 5.10.3 or 5.10.4.

In the case of tests or calibrations performed for internal customers, or in the case of a written agreement with the customer, the results may be reported in a simplified way. Any information listed in 5.10.2 to 5.10.4 which is not reported to the customer shall be readily available in the laboratory which carried out the tests and/or calibrations.

NOTE 1 Test reports and calibration certificates are sometimes called test certificates and calibration reports, respectively.

NOTE 2 The test reports or calibration certificates may be issued as hard copy or by electronic data transfer provided that the requirements of this International Standard are met.

5.10.2 Test reports and calibration certificates

Each test report or calibration certificate shall include at least the following information, unless the laboratory has valid reasons for not doing so:

a) a title (e.g. "Test Report" or "Calibration Certificate");

b) the name and address of the laboratory, and the location where the tests and/or calibrations were carried out, if different from the address of the laboratory;

c) unique identification of the test report or calibration certificate (such as the serial number), and on each page an identification in order to ensure that the page is recognized as a part of the test report or calibration certificate, and a clear identification of the end of the test report or calibration certificate;

d) the name and address of the customer;

e) identification of the method used;

f) a description of, the condition of, and unambiguous identification of the item(s) tested or calibrated;

g) the date of receipt of the test or calibration item(s) where this is critical to the validity and application of the results, and the date(s) of performance of the test or calibration;

h) reference to the sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results;

i) the test or calibration results with, where appropriate, the units of measurement;

j) the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report or calibration certificate;

k) where relevant, a statement to the effect that the results relate only to the items tested or calibrated.

NOTE 1 Hard copies of test reports and calibration certificates should also include the page number and total number of pages.

NOTE 2 It is recommended that laboratories include a statement specifying that the test report or calibration certificate shall not be reproduced except in full, without written approval of the laboratory.

5.10.3 Test reports

5.10.3.1 In addition to the requirements listed in 5.10.2, test reports shall, where necessary for the interpretation of the test results, include the following:

a) deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions;

b) where relevant, a statement of compliance/non-compliance with requirements and/or specifications;

c) where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit;

d) where appropriate and needed, opinions and interpretations (see 5.10.5);

e) additional information which may be required by specific methods, customers or groups of customers.

5.10.3.2 In addition to the requirements listed in 5.10.2 and 5.10.3.1, test reports containing the results of sampling shall include the following, where necessary for the interpretation of test results:

a) the date of sampling;

b) unambiguous identification of the substance, material or product sampled (including the name of the manufacturer, the model or type of designation and serial numbers as appropriate);

c) the location of sampling, including any diagrams, sketches or photographs;

d) a reference to the sampling plan and procedures used;

e) details of any environmental conditions during sampling that may affect the interpretation of the test results;

f) any standard or other specification for the sampling method or procedure, and deviations, additions to or exclusions from the specification concerned.

5.10.4 Calibration certificates

5.10.4.1 In addition to the requirements listed in 5.10.2, calibration certificates shall include the following, where necessary for the interpretation of calibration results:

a) the conditions (e.g. environmental) under which the calibrations were made that have an influence on the measurement results;

b) the uncertainty of measurement and/or a statement of compliance with an identified metrological specification or clauses thereof;

c) evidence that the measurements are traceable (see Note 2 in 5.6.2.1.1).

5.10.4.2 The calibration certificate shall relate only to quantities and the results of functional tests. If a statement of compliance with a specification is made, this shall identify which clauses of the specification are met or not met.

When a statement of compliance with a specification is made omitting the measurement results and associated uncertainties, the laboratory shall record those results and maintain them for possible future reference.

When statements of compliance are made, the uncertainty of measurement shall be taken into account.

5.10.4.3 When an instrument for calibration has been adjusted or repaired, the calibration results before and after adjustment or repair, if available, shall be reported.

5.10.4.4 A calibration certificate (or calibration label) shall not contain any recommendation on the calibration interval except where this has been agreed with the customer. This requirement may be superseded by legal regulations.

5.10.5 Opinions and interpretations

When opinions and interpretations are included, the laboratory shall document the basis upon which the opinions and interpretations have been made. Opinions and interpretations shall be clearly marked as such in a test report.

NOTE 1 Opinions and interpretations should not be confused with inspections and product certifications as intended in ISO/IEC 17020 and ISO/IEC Guide 65.

NOTE 2 Opinions and interpretations included in a test report may comprise, but not be limited to, the following:

— an opinion on the statement of compliance/noncompliance of the results with requirements;

— fulfilment of contractual requirements;

— recommendations on how to use the results;

— guidance to be used for improvements.

NOTE 3 In many cases it might be appropriate to communicate the opinions and interpretations by direct dialogue with the customer. Such dialogue should be written down.

5.10.6 Testing and calibration results obtained from subcontractors

When the test report contains results of tests performed by subcontractors, these results shall be clearly identified. The subcontractor shall report the results in writing or electronically.

When a calibration has been subcontracted, the laboratory performing the work shall issue the calibration certificate to the contracting laboratory.

5.10.7 Electronic transmission of results

In the case of transmission of test or calibration results by telephone, telex, facsimile or other electronic or electromagnetic means, the requirements of this International Standard shall be met (see also 5.4.7).

5.10.8 Format of reports and certificates

The format shall be designed to accommodate each type of test or calibration carried out and to minimize the possibility of misunderstanding or misuse.

NOTE 1 Attention should be given to the lay-out of the test report or calibration certificate, especially with regard to the presentation of the test or calibration data and ease of assimilation by the reader.

NOTE 2 The headings should be standardized as far as possible.

5.10.9 Amendments to test reports and calibration certificates

Material amendments to a test report or calibration certificate after issue shall be made only in the form of a further document, or data transfer, which includes the statement:

"Supplement to Test Report [or Calibration Certificate], serial number... [or as otherwise identified]",

or an equivalent form of wording.

Such amendments shall meet all the requirements of this International Standard.

When it is necessary to issue a complete new test report or calibration certificate, this shall be uniquely identified and shall contain a reference to the original that it replaces.

Annex A
(informative)

Nominal cross-references to ISO 9001:2000

Table A.1 — Nominal cross-references to ISO 9001:2000

ISO 9001:2000	ISO/IEC 17025
Clause 1	Clause 1
Clause 2	Clause 2
Clause 3	Clause 3
4.1	4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.2, 4.2.1, 4.2.2, 4.2.3, 4.2.4
4.2 1	4.2.2, 4.2.3, 4.3.1
4.2.2	4.2.2, 4.2.3, 4.2.4
4.2.3	4.3
4.2.4	4.3.1, 4.12
5.1	4.2.2, 4.2.3
5.1 a)	4.1.2, 4.1.6
5.1 b)	4.2.2
5.1 c)	4.2.2
5.1 d)	4.15
5.1 e)	4.1.5
5.2	4.4.1
5.3	4.2.2
5.3 a)	4.2.2
5.3 b)	4.2.3
5.3 c)	4.2.2
5.3 d)	4.2.2
5.3 e)	4.2.2
5.4.1	4.2.2 c)
5.4.2	4.2.1
5.4.2 a)	4.2.1
5.4.2 b)	4.2.1
5.5.1	4.1.5 a), f), h)
5.5.2	4.1.5 i)
5.5.2 a)	4.1.5 i)
5.5.2 b)	4.11.1
5.5.2 c)	4.2.4
5.5.3	4.1.6
5.6.1	4.15
5.6.2	4.15
5.6.3	4.15

ISO 9001:2000	ISO/IEC 17025
6.1 a)	4.10
6.1 b)	4.4.1, 4.7, 5.4.2, 5.4.3, 5.4.4, 5.10.1
6.2.1	5.2.1
6.2.2 a)	5.2.2, 5.5.3
6.2.2 b)	5.2.1, 5.2.2
6.2.2 c)	5.2.2
6.2.2 d)	4.1.5 k)
6.2.2 e)	5.2.5
6.3.1 a)	4.1.3, 4.12.1.2, 4.12.1.3, 5.3
6.3.1 b)	4.12.1.4, 5.4.7.2, 5.5, 5.6
6.3.1 c)	4.6, 5.5.6, 5.6.3.4, 5.8, 5.10
6.4	5.3.1, 5.3.2, 5.3.3, 5.3.4, 5.3.5
7.1	5.1
7.1 a)	4.2.2
7.1 b)	4.1.5 a), 4.2.1, 4.2.3
7.1 c)	5.4, 5.9
7.1 d)	4.1, 5.4, 5.9
7.2.1	4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5, 5.4, 5.9, 5.10
7.2.2	4.4.1, 4.4.2, 4.4.3, 4.4.4, 4.4.5, 5.4, 5.9, 5.10
7.2.3	4.4.2, 4.4.4, 4.5, 4.7, 4.8
7.3	5, 5.4, 5.9
7.4.1	4.6.1, 4.6.2, 4.6.4
7.4.2	4.6.3
7.4.3	4.6.2
7.5.1	5.1, 5.2, 5.4, 5.5, 5.6, 5.7, 5.8, 5.9
7.5.2	5.2.5, 5.4.2, 5.4.5
7.5.3	5.8.2
7.5.4	4.1.5 c), 5.8
7.5.5	4.6.1, 4.12, 5.8, 5.10
7.6	5.4, 5.5
8.1	4.10, 5.4, 5.9
8.2.1	4.10
8.2.2	4.11.5, 4.14
8.2.3	4.11.5, 4.14, 5.9
8.2.4	4.5, 4.6, 4.9, 5.5.2, 5.5.9, 5.8, 5.8.3, 5.8.4, 5.9
8.3	4.9
8.4	4.10, 5.9
8.5.1	4.10, 4.12
8.5.2	4.11, 4.12
8.5.3	4.9, 4.11, 4.12

ISO/IEC 17025 covers several technical competence requirements that are not covered by ISO 9001:2000.

Annex B
(informative)

Guidelines for establishing applications for specific fields

B.1 The requirements specified in this International Standard are stated in general terms and, while they are applicable to all test and calibration laboratories, explanations might be needed. Such explanations on applications are herein referred to as applications. Applications should not include additional general requirements not included in this International Standard.

B.2 Applications can be thought of as an elaboration of the generally stated criteria (requirements) of this International Standard for specified fields of test and calibration, test technologies, products, materials or specific tests or calibrations. Accordingly, applications should be established by persons having appropriate technical knowledge and experience, and should address items that are essential or most important for the proper conduct of a test or calibration.

B.3 Depending on the application at hand, it may be necessary to establish applications for the technical requirements of this International Standard. Establishing applications may be accomplished by simply providing detail or adding extra information to the already generally stated requirements in each of the clauses (e.g. specific limitations to the temperature and humidity in the laboratory).

In some cases the applications will be quite limited, applying only to a given test or calibration method or to a group of calibration or test methods. In other cases the applications may be quite broad, applying to the testing or calibration of various products or items or to entire fields of testing or calibration.

B.4 If the applications apply to a group of test or calibration methods in an entire technical field, common wording should be used for all of the methods.

Alternatively, it may be necessary to develop a separate document of applications to supplement this International Standard for specific types or groups of tests or calibrations, products, materials or technical fields of tests or calibrations. Such a document should provide only the necessary supplementary information, while maintaining this International Standard as the governing document through reference. Applications which are too specific should be avoided in order to limit the proliferation of detailed documents.

B.5 The guidance in this annex should be used by accreditation bodies and other types of evaluation bodies when they develop applications for their own purposes (e.g. accreditation in specific areas).

Bibliography

[1] ISO 5725-1, *Accuracy (trueness and precision) of measurement methods and results — Part 1 General principles and definitions*

[2] ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

[3] ISO 5725-3, *Accuracy (trueness and precision) of measurement methods and results — Part 3: Intermediate measures of the precision of a standard measurement method*

[4] ISO 5725-4, *Accuracy (trueness and precision) of measurement methods and results — Part 4: Basic methods for the determination of the trueness of a standard measurement method*

[5] ISO 5725-6, *Accuracy (trueness and precision) of measurement methods and results — Part 6: Use in practice of accuracy values*

[6] ISO 9000:—[1)], *Quality management systems — Fundamentals and vocabulary*

[7] ISO 9001:2000, *Quality management systems — Requirements*

[8] ISO/IEC 90003, *Software engineering — Guidelines for the application of ISO 9001:2000 to computer software*

[9] ISO 10012:2003, *Measurement management systems — Requirements for measurement processes and measuring equipment*

[10] ISO/IEC 17011, *Conformity assessment — General requirements for accreditation bodies accrediting conformity assessment bodies*

[11] ISO/IEC 17020, *General criteria for the operation of various types of bodies performing inspection*

[12] ISO 19011, *Guidelines for quality and/or environmental management systems auditing*

[13] ISO Guide 30, *Terms and definitions used in connection with reference materials*

[14] ISO Guide 31, *Reference materials — Contents of certificates and labels*

[15] ISO Guide 32, *Calibration in analytical chemistry and use of certified reference materials*

[16] ISO Guide 33, *Uses of certified reference materials*

[17] ISO Guide 34, *General requirements for the competence of reference material producers*

[18] ISO Guide 35, *Certification of reference materials — General and statistical principles*

[19] ISO/IEC Guide 43-1, *Proficiency testing by interlaboratory comparisons — Part 1: Development and operation of proficiency testing schemes*

[20] ISO/IEC Guide 43-2, *Proficiency testing by interlaboratory comparisons — Part 2: Selection and use of proficiency testing schemes by laboratory accreditation bodies*

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1) To be published. (Revision of ISO 9000:2000)

[21] ISO/IEC Guide 58:1993, *Calibration and testing laboratory accreditation systems — General requirements for operation and recognition*

[22] ISO/IEC Guide 65, *General requirements for bodies operating product certification systems*

[23] GUM, *Guide to the Expression of Uncertainty in Measurement*, issued by BIPM, IEC, IFCC, ISO, IUPAC, IUPAP and OIML

[24] Information and documents on laboratory accreditation can be found on the ILAC (International Laboratory Accreditation Cooperation): www.ilac.org

ICS 03.120.20
Price based on 28 pages

Appendix J Calibration and Quality Control Criteria Charts

Calibration Criteria Charts

ESB Calibration Criteria Volatile Organic Analyses

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA	EPA 524.2	Volatiles by Purge and Trap	O33	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 20	5	If ICV or CCV fails
CWA	EPA 624	Volatiles by Purge and Trap	O32	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 35	3	If ICV or CCV fails
RCRA	EPA 8260	Volatiles by Purge and Trap	O31	Linear r>0.99, Nonlinear r>0.99/ RSD≤ 15, SPCC and CCCs	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
SDWA	CDoHS	1,2,3-Trichloropropane	O63	Linear r>0.99/ RSD< 20	8	If ICV or CCV fails
SDWA	EPA 504.1	EDB/DBCP	O14	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 20	3 to 5 magnitude using 6	with each run
RCRA	EPA 8011	EDB/DBCP	O47	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 10	Linear-5, Quad-6, Poly-7	with each run
RCRA	EPA 8015	Gasoline-Range Organics	O21	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
Lab policy: For 500 and 600 series test methods, use at least a 3 point calibration for linear curves and more than 3 point calibration for nonlinear curves.						
*SPCC min RF and CCC RSD≤ 30						
updated 10/03/09 SKT						

ESB Calibration Criteria Semivolatile Organic Analyses

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA	EPA 507	N,P Pests	O16	Acceptable ICV and RL Check	1	With each run
RCRA	EPA 8141	Organo-Phosphorus Pests	O53	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	With each run
SDWA	EPA 508	Chlorinated Pests	O15	Linear r≥0.99, Nonlinear r^2≥0.98/ RSD≤ 20	6 to 7	Single peak-If ICV or CCV fails/ Multipeak-If detect
CWA	EPA 608	Chlorinated Pests, PCBs	O24	Linear r≥0.99, Nonlinear r^2≥0.98/ RSD≤ 10	6 to 7	Single peak-If ICV or CCV fails/ Multipeak-If detect
RCRA	EPA 8081	Organochlorine Pests	O54	Linear r≥0.99, Nonlinear r^2≥0.99/ RSD≤ 20	Linear-5, Quad-6, Poly-7	Single peak-If ICV or CCV fails/ Multipeak-If detect
RCRA	EPA 8082	PCB's as Arochlors	O50	Linear r≥0.99, Nonlinear r^2≥0.99/ RSD≤ 20	Linear-5, Quad-6, Poly-7	1016/1260 mix-If ICV or CCV fails/ Multipeak- if detect
SDWA	EPA 515.3	Chlorinated Herbicides	O17	Linear r>0.95, Nonlinear r>0.95/ RSD< 20	6	With each run
RCRA	EPA 8151	Chlorinated Herbicides	O17	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	With each run
CWA	SM6640B	Chlorinated Herbicides	O17	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 20	5	With each run
SDWA	EPA 525	BNA's	O19	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 30	6	With each run
CWA	EPA 625	BNA's	O20	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 35	3	If ICV or CCV fails
RCRA	EPA 8270	BNA's	O43	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 15*	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
SDWA	EPA 531.1	Carbamate Pests	O29	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 20	5	With each run
SDWA	EPA 547	Glyphosate	O28	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 10	5	With each run
SDWA	EPA 548.1	Endothall	O18	Linear r>0.98, Nonlinear r^2>0.98/ RSD< 30	4	With each run
	SM6251B	Haloacetic Acids	O38	Linear r>0.99, Nonlinear r^2>0.98/ RSD< 20	5	With each run
RCRA	EPA 418.1	TPH	O25	RSD < 20	4	With each run
RCRA	EPA 8015	Diesel-Range TPH	O21	Linear r>0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	With each run

Lab policy: For 500 and 600 series test methods, use at least a 3 point calibration for linear curves and more than 3 point calibration for nonlinear curves.

*SPCC min RF and CCC RSD≤ 30

updated 10/03/09 SKT

ESB Calibration Criteria Metals Organic Analyses

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA,CWA	EPA 200.7	ICP	M07	Valid ICV/CCV	1 + blank	With each run
SDWA,CWA	EPA 200.7	HARDNESS	M07	Valid ICV/CCV	1 + blank	With each run
RCRA	EPA 6010	ICP	M09	Valid ICV/CCV	1 + blank	With each run
SDWA,CWA	EPA 200.8	ICPMS	M12	Valid ICV/CCV	1 + blank	With each run
RCRA	EPA 6020	ICPMS	M13	Valid ICV/CCV	1 + blank	With each run
SDWA/CWA	SM3112B	Hg Cold Vapor	M06	$r \geq 0.995$	6 + blank	With each run
RCRA	EPA 7470A	Hg Cold Vapor	M06	$r \geq 0.995$	6 + blank	With each run
RCRA	EPA 7471B	Hg Cold Vapor	M06	$r \geq 0.995$	5 + blank	With each run
CWA	SM3500Cr D	Cr +6	M18	$r \geq 0.995$	6 + blank	Yearly
RCRA	EPA 7196	Cr +6	M18	$r \geq 0.995$	6 + blank	Yearly
SDWA	EPA 218.6*	Cr +6	M16	$r \geq 0.999$ or $r^2 > 0.998$	4 + blank	With each run
RCRA	EPA 7199	Cr +6	M16	$r \geq 0.999$ or $r^2 \geq 0.998$	4 + blank	With each run
*ELAP						
updated 10/03/09 SKT						

ESB Calibration Criteria Inorganic Organic Analyses

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA,CWA	SM2320B	ALKALINITY	I02	valid ICV/CCV	2	weekly
CWA	SM4500NH3 H	AMMONIA	I53	r≥ 0.995	7 + blank	daily
CWA	SM5210B	BOD	I05	Winkler vs Probe differ≤0.4	1	With each run
CWA	SM5210B	CBOD	I05	Winkler vs Probe differ≤0.4	1	With each run
CWA	SM5220D	COD	I07	r2≥0.99	7	yearly
SDWA,CWA	SM4500CL G	CHLORINE, FREE & TOTAL	F08	r2≥0.99	3	yearly
SDWA,CWA	EPA 300.0	Cl,NO3,SO4	I19	r2≥0.99	8	If ICV or CCV fails
CWA	SM4500O C	DISSOLVED OXYGEN	I24	Winkler vs Probe differ≤0.4	1	With each run
CWA	SM4500O G	DISSOLVED OXYGEN	I24	Winkler vs Probe differ≤0.4	1	With each run
RCRA	EPA 9045	pH	I25	valid ICV/CCV	2	With each run
SDWA,CWA	SM4500H+ B	pH	I25	valid ICV/CCV	2	With each run
RCRA	EPA 9040C	CORROSIVITY - pH	I25	valid ICV/CCV	2	With each run
SDWA,CWA	LUFT GCMS	CYANIDE AMENABLE TO CL2	I13	r≥ 0.995	5 + blank	If ICV or CCV fails/ every 2 weeks/or new pyridine or buffer
RCRA	EPA 9012	CYANIDE, TOTAL	I40	r≥ 0.995	5 + blank	If ICV or CCV fails/ every 2 weeks/or new pyridine or buffer
SDWA,CWA	SM4500CN- E	CYANIDE, TOTAL - manual	I40	r≥ 0.995	5 + blank	If ICV or CCV fails/ every 2 weeks/or new pyridine or buffer
RCRA	EPA 9214	FLUORIDE	I16	slope 54-60mV	2	With each run
SDWA/CWA	SM4500F- C	FLUORIDE	I16	slope 54-60mV	2	With each run
RCRA	EPA 1010	IGNITABILITY	I15	81+ 2 degrees F	1	NS
CWA	EPA 351.2	KJELDAHL NITROGEN	I45	r> 0.995	6 + blank	daily
SDWA,CWA	SM4500NO2- B	NITRITE	I22	r2≥ 0.99	5 + blank	Yearly
SDWA,CWA	EPA 300.0 or 3	OXYHALIDES AND BROMIDE	I19A	r2≥ 0.99	5	With each run

ESB Calibration Criteria Inorganic Organic Analyses

SDWA	EPA 314	PERCHLORATE	I19B	r≥ 0.995 or r^2 ≥0.99, %RSD<15	5	If ICV or CCV fails
SDWA	EPA 332	PERCHLORATE	I58	r≥ 0.995	6 + blank	If ICV or CCV fails
SDWA	SM 5530C*	TOTAL PHENOLS	I26	r≥ 0.995	5 + blank	Yearly
CWA	EPA 420.4	TOTAL PHENOLS	I38	r≥ 0.995	5 + blank	If ICV or CCV fails/ each run
CWA	SM4500PB E	PHOSPHORUS, TOTAL	I42	r2≥ 0.99	6 + blank	Yearly
SDWA, CWA	SM4500P E	ORTHO-PHOSPHATE	27	r2≥ 0.99	6 + blank	Yearly
RCRA	Sec. 7.3 SW-84	REACTIVE CYANIDE	I50	r≥ 0.995	5 + blank	If ICV or CCV fails
SDWA,CWA	SM5540C	SURFACTANTS	I21	r2≥0.99	10	Yearly
SDWA,CWA	SM5310B	TOC and DOC	O26	r2≥0.99	7 + blank	If ICV or CCV fails
CWA	SM2130B	TURBIDITY	I36	valid ICV/CCV	4	every 90 days
SDWA	SM5910B	UV254	O39	r≥ 0.995 or r2 >0.99	7 + Blank	Yearly
*Uncertified						
updated 10/03/09 SKT						

Volatile Organic Analyses Method Calibration

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA	EPA 524.2	Volatiles by Purge and Trap	O33	RSD<20	MAG20-3,MAG50-4,MAG100-5	If ICV or CCV fails
CWA	EPA 624	Volatiles by Purge and Trap	O32	RSD<35	3	If ICV or CCV fails
RCRA	EPA 8260	Volatiles by Purge and Trap	O31	SPCC RF/CCC RSD≤ 30, rest<15 Linear r≥0.99, Nonlinear r2≥0.99	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
SDWA	CDoHS	1,2,3-Trichloropropane	O63	RSD< 20	5	NS
SDWA	EPA 504.1	EDB/DBCP	O14	RSD<20	MAG20-3,MAG50-4,MAG100-5	If ICV or CCV fails
RCRA	EPA 8011	EDB/DBCP	O47	RSD<10, r>0.99, r2>0.99	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
RCRA	EPA 8015	Gasoline-Range Organics	O21	Linear r≥0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
edited 10/03/09 SKT						

Semivolatile Organic Analyses Method Calibration

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA	EPA 507	N,P Pesticides	O16	RSD≤20	1,3 to 5*	when ICV/CCV out
RCRA	EPA 8141	Organo-Phosphorus Pesticides	O53	Linear r>0.99, Nonlinear r2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	when ICV/CCV out
SDWA	EPA 508	Chlorinated Pesticides	O15	RSD≤20	MAG20-3,MAG50-4,MAG100-5	when ICV/CCV out
CWA	EPA 608	Chlorinated Pesticides, PCB's	O24	RSD≤10	3	when ICV/CCV out
RCRA	EPA 8081	Organochlorine Pesticides	O54	Linear r≥0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	when ICV/CCV out
RCRA	EPA 8082	PCB's as Arochlors	O50	Linear r≥0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	when ICV/CCV out
SDWA	EPA 515.3	Chlorinated Herbicides	O17	r>0.95/ RSD <20	5	when ICV/CCV out
RCRA	EPA 8151	Chlorinated Herbicides	O17	Linear r>0.99, Nonlinear r2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	when ICV/CCV out
SDWA	EPA 525.2	BNA's	O19	RSD<30	6	If ICV or CCV fails
CWA	EPA 625	BNA's	O20	RSD≤35	3	If ICV or CCV fails
RCRA	EPA 8270	BNA's	O43	SPCC RF min 0.05/CCC RSD≤ 30, rest<15 Linear r>0.99, Nonlinear r2>0.99	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
SDWA	EPA 531.1	Carbamate Pesticides	O29	RSD<20%	3/4/2005	NS
SDWA	EPA 547	Glyphosate	O28	RSD<10%	3	daily
SDWA	EPA 548.1	Endothall	O18	RSD<30	4	NS
SDWA	SM6251B	Haloacetic Acids	O38			
RCRA	EPA 418.1	TPH	O25	NA	NA	NA
RCRA	EPA 8015	Diesel Range HC's	O21	Linear r≥0.99, Nonlinear r^2>0.99/ RSD< 20	Linear-5, Quad-6, Poly-7	If ICV or CCV fails
	* 3 for factor of 20, 4 for factor of 50, 5 for factor of 100 or 1 if sample rarely detected					
Update 10/03/09 SKT						

Trace Metals Method Calibration

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators	Frequency of Calibration
SDWA,CWA	EPA 200.7	ICP	M07	ICV/CCV	NS	Daily
RCRA	EPA 6010	ICP	M09	ICV/CCV	1 + blank	Daily
SDWA,CWA	EPA 200.8	ICPMS	M12	ICV/CCV	1 + blank	NS
RCRA	EPA 6020	ICPMS	M13	ICV/CCV	1 + blank	NS
SDWA/CWA	SM3112B	Hg Cold Vapor	M06	NS	3 + blank, < 2 orders mag	NS
RCRA	EPA 7470A	Hg Cold Vapor	M06	NS	blank	Daily
RCRA	EPA 7471A	Hg Cold Vapor	M06	NS	5 + blank	Daily
CWA	SM3500Cr D	Cr +6	M18	NS	3	NS
RCRA	EPA 7196	Cr +6	M18	NS	NS	Daily
SDWA	EPA 218.6*	Cr +6	M16	r> 0.999 S	3, < 2 orders mag	Daily S
RCRA	EPA 7199	Cr +6	M16	r> 0.999 S	3 + blank, < 2 orders mag	Daily
*ELAP						
pdate 10/03/09 SKT						

Wet Chemistry Analyses Method Calibration

Program	Method	Analyte	SOP	Curve Acceptance Criteria	Number of Calibrators
SDWA,CWA	SM2320B	ALKALINITY	I02	NS	NS
CWA	SM4500NH3 H	AMMONIA	I53	NS	3
CWA	SM5210B	BOD	I05	NS	NS
CWA	SM5210B	CBOD	I05	NS	NS
CWA	SM4500O C	DISSOLVED OXYGEN	I24	NS	NS
CWA	SM4500O G	DISSOLVED OXYGEN	I24	NS	NS
SDWA,CWA	SM4500CL G	CHLORINE, FREE & TOTAL	F08	NS	3
SDWA,CWA	EPA 300.0	Cl,NO3,SO4	I19	NS	3 + blk
CWA	SM5220D	COD	I07	or standards prepared in 4a > 5%	5
CWA	SM2120B	Color	I09	NS	NS
SDWA,CWA	SM2510B	CONDUCTIVITY	I14		
RCRA	EPA 9045C	pH	I25	2nd buffer ±0.05 unit	2
SDWA,CWA	SM4500H+ B	pH	I25	3rd buffer ±0.1 unit	2
RCRA	EPA 9040B	CORROSIVITY - pH DETERMINATION	I25	2nd buffer ±0.05 unit	2
SDWA,CWA	SM4500CN- G	CYANIDE AMENABLE TO CL2	I13		
RCRA	EPA 9012	CYANIDE, TOTAL	I40	NS	7
SDWA,CWA	SM4500CN- E	CYANIDE, TOTAL	I40	NS	NS
RCRA	EPA 9214	FLUORIDE	I16	NS	
SDWA,CWA	SM4500F- C	FLUORIDE	I16	NS	
RCRA	EPA 1010	IGNITABILITY	I15	81± 2 degrees F	1
CWA	EPA 351.2	KJELDAHL NITROGEN	I45	NS	3 + blk
SDWA,CWA	SM4500NO2- B	NITRITE	I22	NS	3
CWA	EPA 1664	OIL AND GREASE	I54		
CWA	EPA 300.0	OXYHALIDES AND BROMIDE	I19A	NS	3 + blk
SDWA	EPA 300.1	OXYHALIDES AND BROMIDE	I19A	RSD<15%	3(1mag), 5(2mag)
SDWA	EPA 332	PERCHLORATE	I58	reinject cal stds 80-120, ≤RL 50-150	5
SDWA	EPA 314	PERCHLORATE	I19B	RSD<15%	5 for 2 orders of mag
SDWA	SM 5530C*	TOTAL PHENOLS	I26	NS	3
CWA	EPA 420.4	TOTAL PHENOLS	I38	NS	5 + blank
SDWA,CWA	SM4500P E	PHOSPHATE, ORTHO	I27	NS	6
CWA	SM4500P E	PHOSPHORUS, TOTAL	I42	NS	6

Wet Chemistry Analyses Method Calibration

RCRA	Sec. 7.3 SW-846	REACTIVE CYANIDE	I50	NS	NS
RCRA	Sec. 7.3 SW-846	REACTIVE SULFIDE	I49	NS	NS
CWA	SM4500S= D	SULFIDE	I33		
RCRA	EPA 9030/9034	SULFIDE	I52		
SDWA,CWA	SM5540C	SURFACTANTS	I21	NS	10
SDWA,CWA	SM5310B	TOC and DOC	O26	NS	3
CWA	SM2130B	TURBIDITY	I36		
SDWA	SM5910B	UV254	O39	r≥0.995	3-linear/5-nonlinear/metho
*Uncertified					
edited 10/03/09 SKT					

Wet Chemistry Analyses Method Calibration

Frequency of Calibration											
NS											
NS											
NS											
NS											
NS											
NS											
NS											
Initially/6months											
w/each tube lot or											
NS											
daily											
daily											
daily											
NS											
new reagent											
NS											
NS											
NS											
NS											
NS											
NS											
NS											
NS											
NS											
NS											

Wet Chemistry Analyses Method Calibration

NS											
NS											
NS											
NS											
ICV/CCV fails											

Wet Chemistry Analyses Method Calibration

Wet Chemistry Analyses Method Calibration

Wet Chemistry Analyses Method Calibration

Quality Control Criteria Charts

Volatile Organic Analyses Method Prescribed Limits

Program	*Method*	*Analyte*	*SOP*	*LFB/LCS*	*MS/LFSM*	*RPD*	*Int Std*	*Surrogate*	*ICV*	*CCV*	*Method Blk*	*CCB*
SDWA	EPA 524.2	Volatiles by Purge and Trap	O33	70-130	NS	NS	>50% of cal, >70% of CCV	QC (>50% of cal, >70% of CCV) Samples ±50	70-130	70-130	est Bkgd	NS
CWA	EPA 624	Volatiles by Purge and Trap	O32	Table 5	Table 5	NS	NS	NS	NS	Table 5	<Interf	NS
RCRA	EPA 8260	Volatiles by Purge and Trap	O31	H≤70-130 S	H≤70-130 S	H	50-200 OF midcal for CCV	H or 20	NS	SPCC min RF/ CCC≤20% IS 50-200	<MDL*	NS
SDWA	CDoHS	1,2,3-Trichloropropane	O63	80-120S	NA	NS	QC ±20	NA	NS	80-120	<MDL S	NS
SDWA	EPA 504.1	EDB/DBCP	O14	70-130S	65-135	NS	NA	NA	70-130	70-130	<MDL S	NS
RCRA	EPA 8011	EDB/DBCP	O47	60-140	NS	RSD <10	NA	NA	60-140	60-140*	<MDL*	NS
RCRA	EPA 8015	Gasoline-Range Organics	O21	H≤70-130 S	H≤70-130 S	H	NA	NA	85-115	85-115	<MDL*	NS
* Method 8000 stipulates that the method blank **should** be < the laboratory MDL or < QAPP or <5% the regulatory limit or < 5% the sample result whichever is greater.												
Method 8000 also suggests that CCV results should be ± 15%.												
Updated 10/03/09 SKT												

Semivolatile Organic Analyses Method Prescribed Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	Int Std	Surro - gate	ICV	CCV	Method Blk	CCB
SDWA	EPA 507	N,P Pesticides	O16	H≤T2±30/20	T2±35	NS	70-130 of CCV	70-130	80-120	80-120	< Interf.	NS
RCRA	EPA 8141	Organo-Phosphorus Pest	O53	H≤70-130 S	H≤70-130 S	H	50-150 of cal	H or 20	85-115	85-115	<MDL*	
SDWA	EPA 508	Chlorinated Pesticides	O15	H≤T2±30/20	T2±35	NS	NA	70-130	NS	80-120	<Interf	
CWA	EPA 608	Chlorinated Pest, PCB's	O24	Table 3	Table 3	NS	NA	NS	NS	85-115	<Interf	
RCRA	EPA 8081	Organochlorine Pesticides	O54	H≤70-130 S	H≤70-130 S	H	NA	H or 20	NS	85-115	<MDL*	
RCRA	EPA 8082	PCB's as Arochlors	O50	H≤70-130 S	H≤70-130 S	H	NA	H or 20	NS	85-115	<MDL*	
SDWA	EPA 515.3	Chlorinated Herbicides	O17	NS	70-130	NS	70-130	70-130	70-130	70-130	<MDL	
RCRA	EPA 8151	Chlorinated Herbicides	O17	H≤70-130 S	H≤70-130 S	H	NS	H or 20	85-115	85-115	<MDL*	
SDWA	EPA 525.2	BNA's	O19	x≤70-130/30	x≤70-130/30	NS	>70 S	ICV/CCV 70-130	70-130	70-130	<est bkgd	
CWA	EPA 625	BNA's	O20	Table 6	Table 6	NS	NS	NS	80-120	80-120	<Interf	
RCRA	EPA 8270	BNA's	O43	H≤70-130 S	H≤70-130 S	H	For CCV 50-200/ RT < 30 sec	H or 20	NS	SPCC min RF 0.05/CCC RPD≤20	<MDL*	
SDWA	EPA 531.1	Carbamate Pesticides	O29	H≤80-120/20 S	65-135	NS	NA	NA	80-120	80-120	< Interf.	
SDWA	EPA 547	Glyphosate	O28	H/T2±30/30	H of LFB/T2±30/30	NS	NA	NA	80-120	80-120	< Interf.	
SDWA	EPA 548.1	Endothall	O18	H/T2±20/30	H/T2±20/30	NS	70-130 of recent CCV	NA	70-130 IStd 50-150	70-130 IStd 50-150	< Interf.	
SDWA	SM6251B	Haloacetic Acids	O38	HS	H/T5±30/30	H	80-120	70-130	85-115	85-115	x±3s<MDL	
RCRA	EPA 418.1	TPH	O25	NA	NA	NA	NA	NA	NA	NA	NA	NA
RCRA	EPA 8015	Diesel-Range Organics	O21	H≤70-130 S	H≤70-130 S	H	NA	NA	85-115	85-115	<MDL*	

* Method 8000 stipulates that the method blank should be < the laboratory MDL or < QAPP or <5% the regulatory limit or < 5% the sample result whichever is greater.

Method 8000 also suggests that CCV results should be ± 15%.

updated 1/10/09 SKT

Trace Metals Method Prescribed Limits

Program	*Method*	*Analyte*	*SOP*	*LFB/LCS*	*MS/LFSM*	*RPD*	*Int Std*	*ICV*	*CCV*	*Method Blk*	*CCB*
SDWA,CWA	EPA 200.7	ICP	M07	H≤85-115	70-130orT9	NS	NS	NS	AC - 5%, REST10%, RSD<3%	<MDL	<IDL but >3s
RCRA	EPA 6010	ICP	M09	NS	75-125orH	20orH	NS	90-110, RSD<5%	90-110, RSD<5%	NS	<3xIDL
SDWA,CWA	EPA 200.8	ICPMS	M12	H≤85-115	70-130	NS	60-125	90-110orT8	10%recal, 15%reanal	<MDL	NS
RCRA	EPA 6020	ICPMS	M13	NS	75-125 or H	20	CCB,CCV 20%, rest 30-120%	NS	90-110	NS	<3xIDL
SDWA/CWA	SM3112B	Hg Cold Vapor	M06	90-110	85-115	50/20	NA	H≤90-110	H≤90-110	<MDL	
RCRA	EPA 7470A	Hg Cold Vapor	M06	90-110	NS	NS	NA	90-110	80-120	NS	NS
RCRA	EPA 7471B	Hg Cold Vapor	M06	90-110	NS	NS	NA	90-110	80-120	NS	NS
CWA	SM3500Cr D	Cr +6	M18	90-110	80-120	50/20	NA	NS	NS		
RCRA	EPA 7196	Cr +6	M18	NS	85-115	NS	NA	90-110	90-110		
SDWA*	EPA 218.6	Cr +6	M16	H/90-110	H/90-110	NS	NA	NS	95-105	<MDL	NS
RCRA	EPA 7199	Cr +6	M16	90-110	NS	20	NA	90-110	90-110	NS	NS
*ELAP											
# MB<10% of sample or 2.2 x MDL whichever is greater											
updated 10/03/09 SKT											

Wet Chemistry Analyses Method Prescribed Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	ICV	CCV	Surrogate	Method Blk
SDWA,CWA	SM2320B	ALKALINITY	I02	90-110	NA	50/20	NA	NA	NA	NS
CWA	SM4500NH3 H	AMMONIA	I53	90-110	80-120	50/20	NS	NS	NA	
CWA	SM5210B	BOD	I05	H≤ 198±30.5	NA	NS	NA	NA	NA	
CWA	SM5210B	CBOD	I05	H≤ 198±30.5	NA	NS	NA	NA	NA	
CWA	SM4500O C	DISSOLVED OXYGEN	I24	90-110	NA	NS	NA	NA	NA	
CWA	SM4500O G	DISSOLVED OXYGEN	I24	90-110	NA	0.05±	NS	NS	NA	
SDWA,CWA	SM4500CL G	CHLORINE, FREE & TOTAL	F08	90-110	NA	50/20	NA	NA	NA	
SDWA,CWA	EPA 300.0	Cl,NO3,SO4	I19	H≤90-110S	H/80-120	NS	90-110	90-110	NA	<MDL
CWA	SM5220D	COD	I07	90-110	80-120	50/20	95-105	95-105	NA	NS
CWA	SM2120B	Color	I09						NA	
SDWA,CWA	SM2510B	CONDUCTIVITY	I14	90-110	NA	50/20	NS	NS	NA	
RCRA	EPA 9045	pH	I25	NS	NA	NS	90-110	90-110	NA	
SDWA,CWA	SM4500H+ B	pH	I25	0.1±	NA	50/20	0.1±	NS	NA	
RCRA	EPA 9040C	CORROSIVITY - pH	I25	NS	NA	NS	90-110	90-110	NA	
SDWA,CWA	SM4500CN- G	CYANIDE AMENABLE TO CL2	I13	90-110	80-120	50/20	NA	NA	NA	
RCRA	EPA 9012	CYANIDE, TOTAL	I40	NS	NS	NS	85-115	85-115	NA	
SDWA,CWA	SM4500CN- E	CYANIDE, TOTAL - manual	I40	90-110	80-120	NS	NS	NS	NA	
RCRA	EPA 9214	FLUORIDE	I16	NS	75-125	NS	90-110	90-110	NA	
SDWA,CWA	SM4500F- C	FLUORIDE	I16	90-110	80-120	NS	NS	NS	NA	
RCRA	EPA 1010	IGNITABILITY	I15	± 2°F	NA	NS	NA	NA	NA	
CWA	EPA 351.2	KJELDAHL NITROGEN	I45	H≤ 90-110	90-110	NS	90-110	90-110	NA	<MDL
SDWA,CWA	SM4500NO2- B	NITRITE	I22	90-110	80-120	NS	NS	NS	NA	
CWA	EPA 1664	OIL AND GREASE	I54	HEM 78-114 SGT 64-132	HEM 78-114 SGT 64-132	NS	2mg 10% 1000mg 0.5%	2mg 10% 1000mg 0.5%	NA	<RL
CWA	EPA 300.0	OXYHALIDES AND BROMIDE	I19A	H≤90-110S	H/75-125 Br H/80-120	NS	90-110 RT ^ <10%	90-110 RT ^ <10%	NA	<MDL
SDWA	EPA 300.1	OXYHALIDES AND BROMIDE	I19A	H≤75-125 if ≥10xRL do 85-115	H≤75-125	NS	75-125 if ≥ 10RL do 85-115 RT ^ <5%	75-125 if ≥ 10RL do 85-115 RT ^ <5%	90-115	<MDL

Wet Chemistry Analyses Method Prescribed Limits

SDWA	EPA 332	PERCHLORATE	I58	50-150 <=RL 80-120	50-150 sample≤RL 80-120	50 ≤2xRL 20	80-120	80-120 endCCV RL 50-150	NA	<1/3RL
SDWA	EPA 314	PERCHLORATE	I19B	85-115	80-120	NS	90-110	85-115	NA	<1/2 RL
SDWA*	SM 5530C*	TOTAL PHENOLS	I36	80-120	80-120	NS	NS	NS	NA	NS
CWA	EPA 420.4	TOTAL PHENOLS	I38	90-110	90-110	NS	90-110	90-110	NA	<MDL
		Analyte	***SOP***	***LFB/LCS***	***MS/LFSM***	NS	***ICV***	***CCV***	***Surrogate***	***Method Blk***
SDWA,CWA	SM4500P E	PHOSPHATE, ORTHO	I27	90-110	80-120	NS	NS	NS	NA	
CWA	SM4500P E	PHOSPHORUS, TOTAL	I42	90-110	80-120	NS	NS	NS	NA	NS
RCRA	Sec. 7.3 SW-846	REACTIVE CYANIDE	I50	H	NA	NS	NS	NS	NA	
RCRA	Sec. 7.3 SW-846	REACTIVE SULFIDE	I49	H	NA	NS	NS	NS	NA	
SDWA,CWA	SM2540C	RESIDUE, DISSOLVED	I29	90-110	NA	NS	NA	NA	NA	
CWA	SM2540B	RESIDUE, TOTAL	I28	90-110	NA	NS	NA	NA	NA	
CWA	SM2540D	RESIDUE, NONFILTERABLE	I31	90-110	NA	NS	NA	NA	NA	
CWA	SM2540F	RESIDUE, SETTLEABLE	I30	NA	NA	NS	NA	NA	NA	
CWA	EPA 160.4	RESIDUE, VOLATILE	I32	NS	NA	NS	NA	NA	NA	
CWA	SM4500SD	SULFIDE	I33	NA	NA	NS	NA	NA	NA	
RCRA	EPA 9030/9034	SULFIDE	I52	NA	NA	NS	NA	NA	NA	
SDWA,CWA	SM5540C	SURFACTANTS	I21	NS	NS	NS	NS	NS	NA	
SDWA,CWA	SM5310B	TOC and DOC	O26	90-110	80-120	NS	NS	NS	NA	NS
CWA	SM2130B	TURBIDITY	I36	90-110	NA	NS	NS	NS	NA	
SDWA	SM5910B	UV254	O39	NS	NS	NS	NS	13%RSD	NA	NS
*Uncertified										
updated 10/03/09 SKT										

Wet Chemistry Analyses Method Prescribed Limits

CCB	
NS	
NS	
NS	

Wet Chemistry Analyses Method Prescribed Limits

<1/3RL	
NS	
NS	
beg/10/end	
CCB	

Microbiology Analyses Method Limits

Program	Method	Analyte	SOP	Positive Control	Negative Control	Blank	Duplicate
CHROMOGENIC							
COLILERT							
SDWA	SM9223 + UV	Total Coliform & E. coli	B03	Yes	Yes	absent	P/A
SDWA	SM9223*	Total Coliform	B03	Yes	Yes	NS	H
SDWA	EC + MUG	E. coli	B03	Yes	Yes	absent	P/A
COLISURE							
SDWA	EC + MUG	E. coli	B10	Yes	Yes	absent	P/A
ENTEROLERT							
CWA		Enteeococci	B11	NS	NS	NS	NS
MULTIPLE TUIBE FERMENTATION							
SDWA	SM9221 A,B,C*	Total Coliform	B02	Yes	Yes	<RL	H
CWA	SM9221B	Total Coliform with Chlorine present	B02	Yes	Yes	<RL	H
SDWA,CWA	SM9221E*	Fecal Coliform	B02	Yes	Yes	<RL	H
CWA	SM9221E	Fecal Coliform with Chlorine present	B02	Yes	Yes	<RL	H
CWA	SM9230B	Fecal Streptococci	B05	Yes	Yes	<RL	H
CWA	SM9230B	Enteeococci	B05	Yes	Yes	<RL	H
TOTAL PLATE COUNT							H
SDWA,CWA	SM9215B	Heterotrophic Bacteria	B07	Yes	Yes	<RL	H
MEMBRANE FILTER							
SDWA	SM9222ABC*	Total Coliform	B06	Yes	Yes	absent or <RL	H
*with Enumeration							
H = Limits are generated from historical results. Limits are calculated as stated in SM Table 9020 VI.							

KEY

NA - QC type not applicable to the method

NS - Limits not specified in the method

S - The method specifies that the following limits "should" be achieved and are a recommendation. Limits **not** followed by an "S" are considered to be a method requirement.

H - Limits must be generated based on the laboratory's historical performance.

Table or T - refer to a table reference in the specific certified method.

RPD 50/20 - A maximum RPD of $\pm$ 50 % is allowed for duplicates < 20 times the MDL, a maximum RPD of + 20 % is allowed for duplicates > 20 times the MDL.

H/70-130 S - Generate historical limits, analyst should use 70-130 until historical limits are generated, the method does not specify that historical limits must be as good as 70-130.

H$\leq$70-130 - Generate historical limits, use 70-130 until historical limits are generated, historical limits must be as good as 70-130 or better.

H$\leq$ T2 $\pm$ 30/20 - Generate historical limits, use IDOC limits from Table 2 (R $\pm$ 30%, %RSD $\pm$ 20) until historical limits are generated, historical limits must be as good as IDOC limits or better.

x 80-120/20 - Use IDOC limits, mean recovery must be 80-120% with an RSD of 20%.

Volatile Organic Analyses ESB Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	Int Std	Surrogate	ICV	CCV	MB	CCB
SDWA	EPA 524.2	Volatiles by Purge & Trap	O33	70-130	H≥70-130	MSD - 40 LCSD - H	50-150 of cal	50-150	70-130	70-130	< RL	NA
CWA	EPA 624	Volatiles by Purge & Trap	O32	Table 5	Table 5	MSD - 40 LCSD - H	50-200 of cal	H, min±20%	70-130	70-130	< RL	NA
RCRA	EPA 8260	Volatiles by Purge & Trap	O31	H min/max 70-130	H min/max 70-130	H, min LCSD 20 MSD 40	50-200 of cal	H, min±20%	SPCC min RF/CCC≤20% REST ≤15%	SPCC min RF/CCC< 20%	< RL	<RL
SDWA	CDoHS	1,2,3-Trichloropropane	O63	80-120	70-130	20	samples 50-150 of cal QC 80-120 of cal	NA	80-120	80-120	<1/2RL	NA
SDWA	EPA 504.1	EDB/DBCP	O14	70-130	65-135	40	NA	NA	70-130	70-130	<MDL	<MDL
RCRA	EPA 8011	EDB/DBCP	O47	60-140	H	40	NA	NA	60-140	60-140	<MDL	<MDL
RCRA	EPA 8015	Gasoline-Range Organics	O21	H	H	40	NA	50-150	80-120	80-120	< RL	NA
updated 10/03/09 SKT												

Semivolatile Organic Analyses ESB Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	Int Std	Surrogate	ICV	CCV	Method Blk	CCB
SDWA	EPA 507	N,P Pesticides	O16	H≤T2±30/20	T2±35	H/40	70-130 of CCV	70-130	80-120	80-120	< RL	NA
RCRA	EPA 8141	Organo-Phosphorus Pesticides	O53	H/70-130S	H/70-130aq H/50-150s-sld	H/40	50-150 of cal	H	85-115	85-115	< RL	NA
SDWA	EPA 508	Chlorinated Pesticides	O15	H≤T2±30/20	T2±35	H	NA	70-130	80-120	80-120	< RL	NA
CWA	EPA 608	Chlorinated Pesticides, PCB's	O24	Table 3	Table 3	H	NA	H	85-115	85-115	< RL	NA
RCRA	EPA 8081	Organochlorine Pesticides	O54	H/70-130S	H	H	NA	H	85-115	85-115	< RL	NA
RCRA	EPA 8082	PCB's as Arochlors	O50	H/70-130S	H	H	NA	H	85-115	85-115	< RL	NA
SDWA	EPA 515.3	Chlorinated Herbicides	O17	70-130	70-130	H	70-130 of mean cal	70-130	70-130	70-130	< 1/2 RL	NA
RCRA	EPA 8151	Chlorinated Herbicides	O17	H	H	H	70-130 of mean cal	H	85-115	85-115	< 1/2 RL	NA
SDWA	EPA 525.2	BNA's	O19	x≤70-130/30	x≤70-130/30	40	>70 CCV or >50 cal	70-130	70-130	70-130	< RL	NA
CWA	EPA 625	BNA's	O20	Table 6	Table 6	40	50-200 of midcal or CCV	H	80-120	80-120	< RL	NA
RCRA	EPA 8270	BNA's	O43	H	H	40	50-200 of midcal or CCV	H	SPCC min RF 0.05/CCC RPD≤20,rest RPD<15	SPCC min RF 0.05/CCC RPD≤20	< RL	NA
SDWA	EPA 531.1	Carbamate Pesticides	O29	80-120	65-135	40	NA	NA	80-120	80-120	< RL	NA
SDWA	EPA 547	Glyphosate	O28	80-120	H	40	NA	NA	80-120	80-120	< RL	NA
SDWA	EPA 548.1	Endothall	O18	H/T2±20/30	H/T2±20/30	H	70-130 of CCV	NA	70-130	70-130	< RL	NA
SDWA	SM6251B	Haloacetic Acids	O38	H	H	H	80-120 of CCV	70-130	85-115	85-115	< RL	NA
RCRA	EPA 418.1	TPH	O25	H	H	H	NA	NA	70-130	70-130	<RL	NA
RCRA	EPA 8015	Diesel-Range Organics	O21	H	H	40	NA	H	80-120	80-120	< RL	NA

Semivolatile Organic Analyses ESB Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	Int Std	Surrogate	ICV	CCV	Method Blk	CCB
Updated 01/10/2009SKT												

Wet Chemistry Analyses ESB Limits

SDWA	EPA 332	PERCHLORATE	I58	80-120	80-120	20	80-120	80-120 endCCV RL 50-150	NA	<1/3RL	<1/3RL
SDWA	SM5530C*	TOTAL PHENOLS	I26	80-120	NA	20	80-120	80-120 endCCV RL 50-150	NA	NA	NA
CWA	EPA 420.4	TOTAL PHENOLS	I38	90-110	90-110	20	90-110	90-110	NA	<MDL	b/10/end
SDWA,CWA	SM4500P E	PHOSPHATE, ORTHO	I27	90-110	80-120	20	90-110	85-115	NA	<RL	NA
CWA	SM4500P E	PHOSPHORUS, TOTAL	I42	80-120	80-120	20	90-110	85-115	NA	<RL	NA
RCRA	Sec. 7.3 SW-846	REACTIVE CYANIDE	I50	H	NA	20	85-115	85-115	NA	<RL	NA
RCRA	Sec. 7.3 SW-846	REACTIVE SULFIDE	I49	H	NA	20	NA	NA	NA	<RL	NA
SDWA,CWA	SM2540C	RESIDUE, DISSOLVED	I29	90-110	NA	20	NA	NA	NA	<RL	NA
CWA	SM2540B	RESIDUE, TOTAL	I28	90-110	NA	20	NA	NA	NA	<RL	NA
CWA	SM2540D	RESIDUE, NONFILTERABLE	I31	90-110	NA	25	NA	NA	NA	<RL	NA
CWA	SM2540F	RESIDUE, SETTLEABLE	I30	NA	NA	0.1±	NA	NA	NA	<RL	NA
CWA	EPA 160.4	RESIDUE, VOLATILE-FIXED	I32	80-120	NA	25	NA	NA	NA	<RL	NA
CWA	SM4500S= D	SULFIDE	I33	NA	NA	±0.1, ±0.2, 20	NA	NA	NA	<RL	NA
RCRA	EPA 9030/9034	SULFIDE	I52	NA	NA	NS	NA	NA	NA	<RL	NA
SDWA,CWA	SM5540C	SURFACTANTS	I21	H	H	20	80-120	H	NA	<RL	NA
SDWA,CWA	SM5310B	TOC and DOC	O26	TOC 90-110 DOC H	80-120	10	90-110	85-115	NA	<RL	<RL
CWA	SM2130B	TURBIDITY	I36	90-110	NA	20	90-110	90-110	NA	<RL	NA
SDWA	SM5910B	UV254	O39	90-115	NA	20	90-115	80-120	NA	<RL	<RL
*Uncertified											
updated 10/03/09 SKT											

Wet Chemistry Analyses ESB Limits

Program	Method	Analyte	SOP	LFB/LCS	MS/LFSM	RPD	ICV	CCV	Surrogate	Method Blk	CCB
SDWA,CWA	SM2320B	ALKALINITY	I02	95-105	NA	20	0.1±	0.1±	NA	<RL	NA
CWA	SM4500NH3 H	AMMONIA	I53	90-110	80-120	20	90-110	85-115	NA	<RL	<RL
CWA	SM5210B	BOD	I05	H≤198±30.5	NA	20	H≤198±30.5	H≤198±30.5	NA	<0.5 DO	NA
CWA	SM5210B	CBOD	I05	H≤198±30.5	NA	20	NA	NA	NA	<0.5 DO	NA
CWA	SM4500O C	DISSOLVED OXYGEN	I24	NA	NA	20	NA	NA	NA	NA	NA
CWA	SM4500O G	DISSOLVED OXYGEN	I24	NA	NA	20	NA	NA	NA	NA	NA
SDWA,CWA	SM4500CL G	CHLORINE, FREE & TOTAL	F08	90-110	NA	± 0.1 mg/L	90-110	90-110	NA	NA	NA
SDWA,CWA	EPA 300.0	Cl,NO3,SO4	I19	90-110	H/80-120	20	90-110	90-110	NA	<RL	<RL
CWA	SM5220D	COD	I07	95-105	80-120	20	95-105	95-105	NA	<RL	NA
CWA	SM2120B	Color	I09	±1 color unit	NA	±1 color unit	NA	NA	NA	<RL	NA
SDWA,CWA	SM2510B	CONDUCTIVITY	I14	90-110	NA	20	90-110	90-110	NA	NA	NA
RCRA	EPA 9045	pH	I25	0.1±	NA	0.1±	0.1±	90-110	NA	NA	NA
SDWA,CWA	SM4500H+ B	pH	I25	0.1±	NA	0.1±	0.1±	90-110	NA	NA	NA
RCRA	EPA 9040C	CORROSIVITY - pH	I25	0.1±	NA	0.1±	0.1±	90-110	NA	NA	NA
SDWA,CWA	SM4500CN- G	CYANIDE AMENABLE TO CL2	I13	70-130	NA	30	NA	NA	NA	<RL	NA
RCRA	EPA 9012	CYANIDE, TOTAL	I40	H	H	30	85-115	85-115	NA	<RL	NA
SDWA,CWA	SM4500CN- E	CYANIDE, TOTAL - manual	I40	H	H	20/30	85-115	85-115	NA	<RL	NA
RCRA	EPA 9214	FLUORIDE	I16	75-125	75-125	20	90-110	90-110	NA	<RL	<RL
SDWA,CWA	SM4500F- C	FLUORIDE	I16	90-110	75-125	20	90-110	85-115	NA	<RL	NA
RCRA	EPA 1010	IGNITABILITY	I15	± 2°F	NA	section 14	NA	NA	NA	NA	NA
CWA	EPA 351.2	KJELDAHL NITROGEN	I45	80-120	H	25	90-110	85-115	NA	<RL	<RL
SDWA,CWA	SM4500NO2- B	NITRITE	I22	90-110	80-120	20	90-110	90-110	NA	<RL	NA
CWA	EPA 1664	OIL AND GREASE	I54	HEM 78-114 SGT 64-132	HEM 78-114 SGT 64-132	HEM 18 SGT 34	NA	NA	NA	<RL	NA
CWA	EPA 300.0	OXYHALIDES AND BROMIDE	I19A	90-110	80-120	20	90-110	90-110	NA	<1/2RL	<1/2RL
SDWA	EPA 300.1	OXYHALIDES AND BROMIDE	I19A	85-115	75-125	20 if ≥ 10RL do 10	85-115	85-115	90-115	<1/2RL	<1/2RL
SDWA	EPA 314	PERCHLORATE	I19B	85-115	80-120	15	90-110	85-115	NA	<1/2RL	<1/2RL

Trace Metals ESB Limits

Program	*Method*	*Analyte*	*SOP*	*LFB/LCS*	*MS/LFSM*	*RPD*	*Int Std*	*ICV*	*CCV*	*Method Blk*	*Cal Blk*
SDWA,CWA	EPA 200.7	ICP	M07	85-115	70-130	20	NS	90-110	AC 5% REST10% RSD<3%	<1/2RL	<1/2RL
RCRA	EPA 6010	ICP	M09	85-115	75-125	20	NS	90-110, RSD<5%	90-110, RSD<5%	<1/2RL	<1/2RL
SDWA,CWA	EPA 200.8	ICPMS	M12	85-115	70-130	20	60-125	90-110	10%recal, 15%reanal	<1/2RL	<1/2RL
RCRA	EPA 6020	ICPMS	M13	85-115 or H	75-125 or H	20	CCB,CCV 20%, rest 30-120%	90-110	90-110	<1/2RL	<1/2RL
SDWA/CWA	SM3112B	Hg Cold Vapor	M06	90-110	85-115	20	NA	90-110	90-110	<MDL	<MDL
RCRA	EPA 7470A	Hg Cold Vapor	M06	90-110 CAM/TCLP 80-120	80-120 CAM/TCLP 75-125	20	NA	90-110	90-110	<1/2RL	<1/2RL
RCRA	EPA 7471B	Hg Cold Vapor	M06	H	H	H	NA	90-110	90-110	<1/2RL	<1/2RL
CWA	SM3500CrD	Cr +6	M18	90-110	80-120	20	NA	90-110	90-110	<1/2RL	NA
RCRA	EPA 7196	Cr +6	M18	90-110	85-115	20	NA	90-110	90-110	<1/2RL	NA
SDWA	EPA 218.6*	Cr +6	M16	90-110	H	20	NA	90-110	95-105	<1/2RL	<1/2RL
RCRA	EPA 7199	Cr +6 (l)	M16	90-110	H	20	NA	90-110	90-110	<1/2RL	<1/2RL
RCRA	EPA 7199	Cr +6 (s)	M16	80-120	H	20	NA	90-110	90-110	<1/2RL	<1/2RL
*ELAP											

Microbiology Analyses ESB Limits

Program	Method	Analyte	SOP	Positive Control	Negative Control	Blank	Duplicate
CHROMOGENIC							
COLILERT							
SDWA	SM9223 + UV	Total Coliform & E. coli	B03	Yes	Yes	absent	P/A
SDWA	SM9223*	Total Coliform	B03	Yes	Yes	<RL	H
SDWA	EC + MUG	E. coli	B03	Yes	Yes	absent	P/A
COLISURE							
SDWA	EC + MUG	E. coli	B10	Yes	Yes	absent	P/A
ENTEROLERT							
CWA		Enteeococci	B11	Yes	Yes	absent	P/A
MULTIPLE TUIBE FERMENTATION							
SDWA	SM9221 A,B,C*	Total Coliform	B02	Yes	Yes	<RL	H
CWA	SM9221B	Total Coliform with Chlorine present	B02	Yes	Yes	<RL	H
SDWA,CWA	SM9221E*	Fecal Coliform	B02	Yes	Yes	<RL	H
CWA	SM9221E	Fecal Coliform with Chlorine present	B02	Yes	Yes	<RL	H
CWA	SM9230B	Fecal Streptococci	B05	Yes	Yes	<RL	H
CWA	SM9230B	Enteeococci	B05	Yes	Yes	<RL	H
TOTAL PLATE COUNT							H
SDWA,CWA	SM9215B	Heterotrophic Bacteria	B07	Yes	Yes	<RL	H
MEMBRANE FILTER							H
SDWA	SM9222ABC*	Total Coliform	B06	Yes	Yes	absent or <RL	H
*with Enumeration							
H = Limits are generated from historical results. Limits are calculated as stated in SM Table 9020 VI.							

KEY

NA - QC type not applicable to the method

NS - Limits not specified in the method. Laboratory limits generated from historical data.

S - The method specifies that the following limits "should" be achieved and are a recommendation. Limits **not** followed by an "S" are considered to be a method requirement.

H - Limits must be generated based on the laboratory's historical performance.

Table or T - refer to a table reference in the specific certified method.

RPD 50/20 - A maximum RPD of $\pm$ 50 % is allowed for duplicates < 20 times the MDL, a maximum RPD of + 20 % is allowed for duplicates > 20 times the MDL.

H/70-130 S - Generate historical limits, analyst should use 70-130 until historical limits are generated, the method does not specify that historical limits must be as good as 70-130.

H$\leq$70-130 - Generate historical limits, use 70-130 until historical limits are generated, historical limits must be as good as 70-130 or better.

H$\leq$ T2 $\pm$ 30/20 - Generate historical limits, use IDOC limits from Table 2 (R $\pm$ 30%, %RSD $\pm$ 20) until historical limits are generated, historical limits must be as good as IDOC limits or better.

x 80-120/20 - Use IDOC limits, mean recovery must be 80-120% with an RSD of 20%.

Appendix K Sample Forms:

Chain of Custody and Sample Receipt

E.S.BABCOCK&Sons,Inc.
Environmental Laboratories est 1906

6100 Quail Valley Court Riverside, CA 92507
(951) 653-3351 • FAX (951) 653-1662
www.babcocklabs.com

Chain of Custody & Sample Information Record

Client: | Contact: | Fax No.

Phone No. | email:

Project Name: | Turn Around Time: Routine *72 Hour Rush *48 Hour Rush *24 Hour Rush

Project Location: | *Lab TAT Approval: | By: | *Additional Charges Apply

Additional Reporting Requests
Include QC Data Package: ☐ Yes ☐ No
FAX Results: ☐ Yes ☐ No
Email Results: ☐ Yes ☐ No
State EDT: ☐ Yes ☐ No
(Include Source Number in Notes)

Sampler Information

Name: _____

Employer: _____

Signature: _____

Sample ID	Date	Time	# of Containers & Preservatives: Unpreserved	H_2SO_4	HCl	HNO_3	$Na_2S_2O_3$	NaOH	NaOH/Zn Acetate	NH_4Cl	MCAA	Total # of Containers	Sample Type: Routine	Resample	Special	Analysis Requested	Matrix	Notes
																	DW = Drinking Water WW = Waste Water GW = Ground Water S = Source SG = Sludge L = Liquid M = Miscellaneous	

Relinquished By (sign)	Print Name / Company	Date / Time	Received By (sign)	Print Name / Company

(For Lab Use Only) Sample Integrity Upon Receipt/Acceptance Criteria

Sample(s) Submitted on Ice? Yes No
Custody Seal(s) Intact? Yes No NA
Sample(s) Intact? Yes No
Temperature: _____ °C ☐ Cooler Blank

Sample meets laboratory acceptance criteria? Yes No
Permission to continue: Yes No
Deviation/Notes: _____
Signature/Date: _____

Lab No. _____

Logged in By/Date: _____

Page _____ of _____

Rev. 3/09

Edward S. Babcock & Sons, Inc.
Terms & Conditions

PAYMENT TERMS AND CONDITIONS

Prepayment is required for all first time clients.
Payment terms are net 30 days of invoice date, upon approved credit. A finance charge of 1.5%/mo (18% annually) will be applied to all unpaid balances 30 days past the due date. The minimum charge is $10.
Delinquent accounts will be on a prepayment/C.O.D. basis only.
Past Due under this contract is not dependent upon receipt of payment by clients' third party and/or user, and client is solely responsible for timely payment of all invoices not withstanding payment or non-payment by any said third party and/or user.

AVAILABLE SERVICES

Courier services, sample bottle kits, Chain of Custody Forms, seals & labels.

REPORTING

A Standard QC package, when requested, may contain any combination of the following: Method Blank (MB), Lab Control Sample (LCS), Lab Control Sample Duplicate (LCSD), Matrix Spike (MS), Matrix Spike Duplicate (MSD), Sample Duplicate (DUP), and/or Surrogate (SURR). Electronic deliverables can be provided for a nominal fee.

SPECIAL NEEDS, CHARGES

A $75 minimum charge per submission applies. Extra charges may apply for rush analysis, special sample preparation, non-typical report format, or other non-typical customer requests or needs. Prices are based on the estimated quantities. Should the Scope of Work change, contact ESB for price verification. Additional charges may be assessed for Trip Blank analysis and samples requiring multiple dilutions due to client specific reporting requirements.

SAMPLE SUBMISSION

Before submitting a sample, new clients must fill out a New Client information form.
Results only apply to the samples submitted.
When submitting a sample the following paperwork must be submitted.
Chain of Custody: Include sample identification, name and address, telephone and fax numbers, written instructions or list of analyses to be performed, email address, date and signature.
Price Quote: A copy of the official price quote (if obtained) must be submitted with the sample.
Samples must be submitted on ice to help maintain the integrity of the sample
All samples must be clearly labeled and identified. Instructions must be included with the sample, not separately.
ESB reserves the right to refuse samples at its discretion
Sample turnaround time is 7-10 working days from the date of sample receipt. Standard turnaround time for hardcopy results is 5 working days from the date of verbal/fax results.

SUBCONTRACTED ANALYSIS

Should instrumentation problems, special methods, or circumstances out of the laboratory's control occur, the project may be subcontracted to a State certified subcontract lab. Additional charges may be incurred. In addition, prices for subcontracted analysis are subject to change. Please phone your Project Manager prior to sample submittal to verify pricing and TAT.

SAMPLE DISPOSAL

If a sample is contaminated, either the client may take custody of the sample, or ESB will arrange for proper disposal and bill the client directly.

POLICIES

ESB 's liability for any service rendered or test performed on behalf of a client is limited to the amount ESB has been paid by the client for that particular test or service. ESB will not be liable for any consequential damages allegedly sustained by the client as a result of or in connection with a test or service performed by ESB. Under no circumstance shall ESB's liability arising from or in connection with the performance of a test or service exceed the amount it was paid for that test or service.

Repeat Analyses: ESB may repeat analyses per the client's request. If the repeat analyses results confirm the original results, the client may be charged for the duplicate testing.

ESB may at its sole discretion destroy any and all materials in conjunction with the services rendered pursuant to this contract after a period of seven (7) years from date that services were last provided by ESB to client. It is the client's responsibility to advise ESB of any pending litigation that may require retention of records.

ESB retains the following certifications: NELAP #02101CA, California ELAP #2698. For specific method and analyte certification information, select the "Company Information" on our website at www.babcocklabs.com.

I have read and agree to the Terms and Conditions listed above.

Signature: _____ Date: _____

Company Name: _____ Phone Number: ( ) _____

E.S.BABCOCK&Sons,Inc.
Environmental Laboratories est 1906

Sample Acceptability Waiver Form
E. S. Babcock & Sons, Inc.

Client:_____

_____

This waiver applies to the following:
Sample I.D., Project, or All future samples (circle one)

_____

_____

_____

_____

_____

Sample Acceptability Problem:

Improper containers	_____
Improper preservative	_____
Improper temperature	_____
Received past holding time	_____
Other:_____	_____

I authorize E.S. Babcock & Sons to continue present and future analyses for samples described above, even if they do not meet the sample acceptance requirements noted above each time they are submitted.

Signature: _____

Print Name: _____

Date: _____

E. S. Babcock & Sons, Inc.
6100 Quail Valley Ct., Riverside, CA 92507
(909) 653-3351

Lab No. _____

Sample Receipt Form

Client: _____

Submitted By: _____

Date: _____

Time _____

Sample Condition

Number of Containers: _____

Temperature: _____ °C

Were Samples Submitted on Ice?	No	Yes	
Were Samples Received Intact?	No	Yes	
Were Samples in Proper Containers?	No	Yes	
Were Sample Custody Seals Intact?	No	Yes	N/A
Chain of Custody Received?	No	Yes	
Submitted within Reg. Holding Times?	No	Yes	
Is there Sufficient Volume?	No	Yes	

Comments: _____

_____

_____

Sample(s) Received By: _____

Problem Contact Information:
Person Contacted: _____ Date/Init.:_____

Permission to Continue? No Yes

Appendix L Sample Preservation and Holding Times

Sample Containers, Preservation Techniques, and Holding Times For Aqueous Matrices

Edward S. Babcock & Sons Standard Operating Procedure
Effective Date__7/13/2011_____

Bacteriological Analyses

Determination	Method	Container/ Volume (mL)	Preservative	Holding Time[1]
Coliform, Total	SM9221B,SM9223	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW
Coliform, Fecal	SM9221E,SM9223	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW
Enterococcus	SM9230B	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW
	ASTM D650399	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW
Heterotrophic Plate Ct.	SM9215B	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW
Streptococcus, Fecal	SM9230B	P,G/Sterile/100	<10°C[12]	6hrsWW/ 8hrsSW/ 30hrsDW

Bacteriological Analyses-Food and Bottled Beverages

Determination	Method	Container/ Volume (mL) ***	Preservative	Holding Time[1]
Yeast & Mold	AOAC 997.02	P,G/Sterile/100	None	NA
HPC/APC	AOAC 966.23/ AOAC 990.12	P,G/Sterile/100	None	30hrsDW/NA others
Acidophiles	CMMEF, 4th Ed.	P,G/Sterile/100	None	NA
E. Coli	BAM-FDA 8th Ed.	P/G/Sterile/100	Sodium Thiosulfate	30hrsDW/NA other
Coliform, Total	AOAC 966.24	P/G/Sterile/100	Sodium Thiosulfate	30hrsDW/NA other
Listeria	AOAC 999.06	P/G/Sterile/ 25grams	None	NA
Salmonella	AOAC 996.08	P/G/Sterile/ 25grams	None	NA
E. Coli 0157:H7	AOAC cert #010504	P/G/Sterile/ 25grams	None	NA

Inorganic Wet Chemistry Analyses

Determination	Method	Container/ Volume (mL)	Preservative	Holding Time[1]
Alkalinity*	SM2320B	P,G/500	≤6°C	14 days
Ammonia	SM4500NH3H	P,G/100	≤6°C H_2S0_4	28 days
Abestos	100.2	P/1000	≤6°C	48 hours[13]
BOD*	SM5210B	P,G/1000	≤6°C	48 hours
Boron	200.7	P/500	$HN0_3$[8]	6 months
Bromate	300.1	P,G/100	EDA	28 days
Bromide*	300.1	P,G/100	None	28 days
Cations(Ca,Mg,Na,K)	200.7	P,G/500	$HN0_3$[8]	6 months
COD	SM5220D	P,G/100	≤6°C, H_2S0_4	28 days
Chloride*	300.0	P,G/100	None	28 days
Chlorine demand	SM2350B	P,G/1000	None	15 minutes
Chlorine dioxide*	SM4500ClO_2D	P,G,/100	None	15 minutes
Chlorine, residual*	SM4500ClG	P,G/100	None	15 minutes
Chlorate	300.1	P,G/100	EDA	28 days
Chlorite	300.1	P,G/100	≤6°C,EDA[17]	14 days
Chromium-Hexavalent	SM3500CrD	P,G/100	≤6°C, NH_4Buffer[15]	WW 28 days
Chromium-Hex.(low level)	218.6	P,G/100	≤6°C, NH_4Buffer[15]	DW/WW 28 days
	7199	P,G/100	≤6°C	GW 24 hours
Color*	SM2120B	P,G/100	≤6°C	48 hours
Cyanide	SM4500CN C E G	P,G/250	≤6°C NaOH[14]	14 days
Dissolved Oxygen	SM4500 O C	G/300	Fixed on site	8 hours
Flashpoint	1010	G/500	None	Not Specified

Inorganic And Wet Chemistry Analyses continued

Determination	Method	Container / Volume (mL)	Preservative	Holding Time[1]
Fluoride*	SM4500 FC	P/100	None	28 days
Hardness (Total)	200.7	P,G/500	$HN0_3$[8]	6 months
Metals ICP (incl. Cations)	200.7,6010B	P,G/500	$HN0_3$[8]	6 months
Metals ICPMS	200.8,6020	P,G/500	$HN0_3$[8]	6 months
Copper/Lead Rule	200.8	P,G/1000	None[16]	6 months
Mercury	7470,7471,200.8	P,G/500	$HN0_3$[8]	28 days
	SM3112B	P,G/500	$HN0_3$[8]	28 days
Nitrate*	300.0	P,G/100	≤6°C	48 hours
Nitrite*	SM4500NO_2B	P,G/100	≤6°C	48 hours
Nitrogen–Total Kjeldahl	351.2	P,G/500	≤6°C, H_2S0_4	28 days
Odor	SM2150B	P,G/100	≤6°C	48 hours
Oil & Grease	1664	G-A/500[10]	≤6°C, H_2S0_4	28 days
PCBSA*	300.0	P,G/100	None	28 days
Perchlorate*	314	P,G/100	≤6°C	28 days
Perchlorate (low level)	332.0/6860	P,G/100sterile	≤6°C,filter with syringe	28 days
pH*	SM4500H+B	P,G/100	None	15 minutes
Phenols	420.4	G-A/250	≤6°C [6], H_2S0_4	28 days
Phenols (low level)	SM5530C	G-A/1000	≤6°C, H_2S0_4	28 days
Phosphates – Ortho*	SM4500P E	P,G/100	≤6°C	48 hours
Phosphorus, Total (as P)	SM4500P E	P,G/100	≤6°C, H_2S0_4	28 days
Silica, Reactive*	SM4500 SiO_2C	P/500	≤6°C	28 days
Silica Total	200.7	P/500	$HN0_3$[8]	6 months
Solids-Dissolved-TDS*	SM2540C	P,G/500	≤6°C	7 days
Solids-Suspended-TSS*	SM2540D	P,G/500	≤6°C	7 days
Solids-Total*	SM2540B	P,G/500	≤6°C	7 days
Solids-Settleable *	SM2540F	P,G/2000	≤6°C	48 hours
Solids-Volatile*	160.4	P,G/500	≤6°C	7 days
Specific Conductance-EC*	SM2510B	P,G/100	≤6°C	28 days
Sulfate*	300.0	P,G/100	≤6°C	28 days
Sulfide, dissolved	SM4500S D	P,G/100[9]	≤6°C zero headspace	15 minutes/7 floc -ZnAc
Sulfide, total	SM4500S D	P,G/100	≤6°C NaOH,ZnAcetate	7 days
Surfactants (MBAS)*	SM5540C	P,G/500	≤6°C	48 hours
Turbidity*	SM2130B	P,G/100	≤6°C	48 hours
Uranium	200.8	P,G/500	$HN0_3$[8]	6 months
UV-254	SM[20th] 5910B	G-TLC-A/250	≤6°C	2 days
Volatile Acids	SM5560C	P,G/500	<6°C	7 days

Radiochemistry Analyses

Determination	Method	Container / Volume (mL)	Preservative	Holding Time[1]
Gross Alpha	900.0,9310	P,G/1000	$HN0_3$[5]	6 months
Gross Beta	900.0,9310	P,G/1000	$HN0_3$[5]	6 months
Uranium	908.0	P,G/1000	$HN0_3$[5]	6 months
Radium 226	903.1	P,G/1000	$HN0_3$[5]	6 months
Radium 228	904.0,9320	P,G/2000	$HN0_3$[5]	6 months
Radon	913	G-TLC-A /2 x 250[11]	≤6°C	4 days
Strontium 90	905.0	P,G/1000	$HN0_3$[5]	6 months
Tritium	906.0	G/1000	None	6 months

Organic Analyses

Determination	Method	Container/ Volume (mL)	Preservative	Holding Time[1] Extraction/Analysis
Semivolatiles, N.P.Pest.	525	G-TLC-A/1000	≤6°C [3], HCl	14/30 days
Base/Neutrals/Acid	625	G-TLC-A/1000	≤6°C [3]	7/40 days
	8270	G-TLC-A/1000	≤6°C [3]	7/40 days
Carbamates	531.1	VOA-G-A/3 x 40 vials	≤6°C, $Na_2S_2O_3$, MCAA[4]	28 days
Chlorinated pests/PCB's	508	G-TLC-A/1000	≤6°C [3]	7/14 days[7]
Chlorinated pesticides	608,8081	G-TLC-A/1000	≤6°C [3]	7/40 days[7]
Polychlorinated Biphenyls	608	G-TLC-A/1000	≤6°C	7/40 days
	8082	G-TLC-A/1000	≤6°C	7/40 days
Chlorinated Herbicides	515.3	G-TLC-A/1000	≤6°C [3]	14/14 days
	8151	G-TLC-A/1000	≤6°C [3]	7/40 days
Diesel Range Organics	8015B	VOA-G/4 x 40 vials, TB[2]	≤6°C, HCl or H2SO4	14 days recom.
Dioxins	1613B	G-A/1000	≤6°C [3]	30 days
Diquat	549.1	P/1000	≤6°C [3]	7 days for ext[13]
EDB and DBCP	504.8011	VOA-G-A/3 x 40 vials	≤6°C, $Na_2S_2O_3$	14 days
Endothall	548.1	G-A/500	≤6°C [3]	7/14 days
Ethylene Glycol	GCFID/MS(8015-Mod)	G-TLC-A/1000	≤6°C	40 days
Gasoline Range Orgs.	8015B	VOA-G/4 x 40 vials	≤6°C, HCl	14 days recom.
Glyphosate	547	VOA-G/3 x 40 vials	≤6°C, $Na_2S_2O_3$	14 days[7]
Haloacetic Acids	SM[19th] 6251B	VOA-G/4 x 40 vials	≤6°C, NH_4Cl	9/21 days
Organophos. Pests.	8141B	G-TLC-A/1000	≤6°C [3]	7/40 days[7]
Total Organic Carbon	SM5310B	P,G/4 x 40 vials	≤6°C, H_2S0_4	28 days
Total Organic Halogen	SM[20th] 5320B	G-TLC-A/250	≤6°C [3], H_2S0_4	28 days
TPH	418.1	G-TLC-A/1000	≤6°C, H_2S0_4	28 days
Trihalomethanes	524.2	VOA-G-A/4 x 40 vials,TB	≤6°C, $Na_2S_2O_3$	14 days
Volatile Organics	524.2,624,8260	VOA-G/4 x 40 vials,TB[2]	≤6°C, HCl[3]	14 days

Notes:

G=Glass, P=Polyethylene (plastic), G-A=Amber Glass, VOA=Vial with Teflon-lined septum – zero head space, G-TLC-A=Amber Glass with Teflon-lined cap, Recom.=recommended,NA=Not Applicable
DW = drinking water, GW = groundwater, SW = source water, WW = wastewater
°C = degrees, floc = flocculate, EDA = Ethylenediamine

SM refers to Standard Methods for the Examination of Water and Wastes, 18th Edition unless otherwise noted. All other methods referenced are EPA numbers, AOAC Method Numbers or BAM-FDA reference methods.

* All of these analyses can be performed out of one 1/2 gallon plastic container.
*** Food and Bottled Beverage samples for Bacteriological analyses are submitted in sealed product containers provided
by client. Container size depends on product container.

1. Holding times per 40 CFR 141 for drinking waters, and CFR 136.3 for wastewaters. Preservative, as indicated, must be present for holding time to be valid.
2. Travel Blank (also preserved with HCl).
3. If Chlorine Residual is present, sodium thiosulfate or sodium sulfite (525) is needed to neutralize free chlorine. Dechlorinator must be added prior to acidification. Nonvolatile samples, suspected of containing chlorine, are screened for chlorine and additional dechlorinator is added as needed. Consult method.
4. Monochloracetic acid (MCAA) buffer (pH3) is added at the ratio of 1.2 mL per 40 mL sample.
5. Sample preserved at lab after Electrical Conductivity is checked.
6. Preserved sample is screened for chlorine as necessary and treated at lab. See SOP A06 for more details.
7. See method exceptions.
8. Sample can be preserved at lab in its original container and must be held ≥ 24 hrs. prior to analysis.
9. Collect grab sample in 1 quart plastic container, fill completely, eliminating all headspace.
10. Grab sample only.
11. Consult laboratory for special instructions.
12. With Sodium thiosulfate
13. Analysis is subbed out. Please allow extra time for short holding time analyses.

14. Client submits unpreserved sample which is screened for sulfide and chlorine as necessary and preserved to pH>12 with NaOH upon receipt to the laboratory. See SOP A06 for more details.
15. Wastewater samples should be filtered in the field (within 15 minutes) and preserved by the laboratory within 24 hours. Drinking water samples should be preserved in the field and filtered at the bench. Preservation includes addition of NH_4 buffer to pH 9.0-9.5.
16. For client safety, sample is preserved at lab with nitric acid, in its original container, and held $\geq$ 24 hrs. prior to analysis.
17. Sparge sample with an inert gas (helium, argon, nitrogen) prior to preservation if chlorine dioxide is present.

Basic Sampling Guidelines

A. Always utilize proper sampling containers and preservatives.
B. For organic analytes, all bottles should have Teflon lined lids, vials should have Teflon lined septa.
C. Soil samples are typically collected in brass or steel tubes and wide mouth jars (500ml) with Teflon-lined caps. Sludges should be collected in wide mouth jars, not brass or steel tubes. Store at $\leq$6°C
D. Aqueous samples for volatile analyses should not have head space between the sample matrix and septum, or bubbles within the sample.
E. Samples requiring organic analyses should never be handled with plastic implements, latex gloves, or stored in plastic containers. Glass is the only acceptable container (except EPA 549).
F. Always use trip blanks when samples require volatile analyses. Fill completely, eliminate all headspace.
G. Keep samples isolated from all possible sources of contamination (i.e., gasoline refueling operations, solvents, paints, lacquers, and adhesives).
H. Always complete a Chain-of-Custody form.
I. Use blue ice packs in coolers when possible.
J. Deliver samples directly to the laboratory as soon as possible.

See SOP A06 for more details concerning sample treatment, preservation and interference screening.

Approved By:____Stacey A. Fry____Date:__ 06/15/2011_______

Appendix M Documentation Audit Forms

Pre-Audit Checklist

Method: _____ Analysis: _____ Audit Date: _____

Analyst(s): _____ SOP# _____

To be filled out by analyst					To be filled out by Auditor			
Item	**Y**	**N**	**NA**	**Comments**	**Correction needed**	**Analyst**	**Date Corrected by analyst**	**Date Approved by Auditor**
Training Documentation:								
I have a current SOP sign off for above listed SOPs								
I have completed and turned in an IDOC for each matrix and test variation								
My training SOP is labeled and all notes are initialed by trainer.(Name_____)								
I have completed and turned in a CDOC for each matrix and sample variation								
Knowledge								
My SOP is correct, I know what it says and I am following it.								
I have read the referenced methods and am familiar with the environmental relevance of the analytes in it.								
Standards and Reagents								
My standards are traceable back to the source.								
My Standards are labeled properly according to SOP Q08.								
I have a standard log for each standard I make and they are complete and up to date.								
My reagents are labeled properly according to SOP Q05.								
I have a reagent log for each reagent I make and they are complete and up to date.								
Comments:								

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
Calibration								
My calibration is clearly labeled with : Date, initials, method #, instrument i.d., icv result and acceptance limits, STD ID#s of Cal source and ICV 2nd source, r^2 value, and calibration std log information.								
My peer review checklist has the correct calibration date on it.								
Bench sheet								
I am using the correct bench sheet for my analysis								
All spaces on bench sheet are accurate and filled out completely.								
Data and Documentation								
all raw data is organized and easily accessible (in data book, labeled and filed, etc.)								
Any changes I make to my data are noted with a single cross out and accompanied by my initials, date and explanation if nec.								
My data page and peer review checklist are correct and filled out completely.								
I have made copies of a run and highlighted the following documentation: method(s), prep method, prep/analysis D/T/I, QC TV, QC limits, pH verification, sample vol, dil, conc, Inst. ID, STD IDs *(Have this ready for review during audit)*								
Questions and concerns:								

Internal Audit Checklist/Corrective Action list

Method: _____ Analysis: _____ Audit Date: _____

Analyst(s): _____ SOP# _____

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
Pre-Audit								
The method reference and version are correct in the SOP and LIMS								
QC,IDOC/MDL/STDs spreadsheets reviewed and current. Method/ESB QC Limit and Calibration spreadsheets are correct.								
Analyst filled out and turned in pre-audit checklist. Auditor reviewed____.								
Corrective action has been taken regarding the following past inspection deficiencies?								
1								
2								
3								

Recent PT failures:

Study_____ Analyte_____ Reported value_____ True Value_____ Pass 2 since ____
Problem_____ Corrective Action_____ Still Followed _____
Study_____ Analyte_____ Reported value_____ True Value_____ Pass 2 since ____
Problem_____ Corrective Action_____ Still Followed _____

Interview with Supervisor/Manager	Y	N	NA	Comments				
Analysis performed in a timely manner?								
Meeting holding times and due dates?								
Autopipet is calibrated monthly?								
Any concerns/issues?								
1								
2								
3								

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
Observation								
SOP								
Does analyst have current sign off for SOP?								
Does SOP need updating?								
Is analyst following SOP?				Sect. #'s missed:				
Analyst Technique								
Proper glassware choice								
Proper measuring technique								
Proper preservation check								
Demonstrates basic skills								
Ensures proper sample position for easy identification								
Works in a safe manner								
Disposes of waste properly								
Analyst Knowledge								
Knows their SOP								
Understands theory of method/instrument								
Understands environmental relevance of analyte								
Understands variations of the method:								
a) other matrices								
b)pretreatment								
c) interference detection and treatment								
Understands safety requirements								
a) location of spill kit/MSDS								
b) Reducing exposure to carcinogens								
c)Test specific concerns:								
Instrumentation/Equipment				Inst #				
Maintenance log(s) accessible								
Maintenance log entries are up to date								
Standards and Reagents								
STDs and Reagents acceptable				See Pre-Audit Checklist (spot check)				

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
Review of Data and Documentation								
QC								
1) Calibration meets requirements				See Pre-Audit Checklist				
2) Proper QC is analyzed (all matrices, var.)								
3) Proper concentration								
4) Proper frequency (per matrix type)								
5) MS/Dup source chosen at random								
6) Within Acceptance limits								
7) Proper Qualifiers/out of control QC flagged, results flagged, follow-up doc.								
8) RL std at end of run								
Data books/Run								
1) Prep or run log is current, neat, orderly								
2) Documentation includes:								
a. prep date and method								
b. date(w/yr)/Time/Initials								
c. batch number								
d. pH verification								
e. QC true values (run/peer/SOP)								
f. sample ID with bottle letter								
g. sample volume, dilutions								
h. method number (on chromatogram)								
i. peer review filled out correctly								
j. calibration date								
k. instrument I.D.								
l. raw result, conc., final result								
3) Calculations correct								
4) proper dilutions are used								
5) Computer entry/ Batch is correct								
6) Crossouts single line/initial/date/reason if								
7) Standards are traceable								
8) Code of ethics included or posted								
9) Old data pages.C of Analysis filed by yr.								
Paper Audit Trail				Lab Number:				
1) Chain of Custody/Sample Receipt Form								
2) Login info								
3) Splitting								
4) Raw Data								
5) Final Report								
6) QC report								

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
NELAP Documentation								
A. IDOC completed on file (Yr.)								
1) Liquid matrix								
2) Solid matrix								
B. Continuing DOC								
1) Liquid matrix								
2) Solid matrix								
C. Training Documentation								
1) Trainer:								
a. Co-initial if no IDoC								
b. Training checklist on file								
c. Training notes on SOP/initialed								
2) Training spreadsheet correct								
D. Backup chemists(name:)								
1) IDOC								
2) CDOC								
3) SOP sign off								
E. Method Detection Limit/ Reporting Limit.								
1) Study is current for method req. freq.								
2) Correct MDL and RIdate in LIMS								
3) Valid LOD Study performed								

Additional issues/items that need to be addressed								

A follow up on any items marked "correction needed" will be due May **11th, 2010** As you finish the above items please update your progress by entering "date corrected" on a copy of this follow up form found in Nas_server/QADept/ Corrective Action List in Progress.
All items must be completed by the above due date. If you need an extension, please request one at least one week prior to your due date. Unless there are extenuating circumstances, there will be a formal write up if everything is not completed by the extension date. Thank you for your cooperation.

Julia Sudds, Quality Assurance Auditor

Analyst_____Date_____

Analyst_____Date_____

Supervisor_____Date_____

Lab Director_____Date_____

cc_____

Follow Up Date _____

The Analyst has modified his/her analysis to correct all Audit deficiencies. Yes_____ No _____

Follow Up Comments: _____

_____

_____

_____ _____

Analyst Auditor

updated 3/21/11 JB

Supplemental Audit Checklist/Corrective Action list

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
IC								
A. Calibration								
1) Type of curve used _____acceptable								
2) Nonlinear ok?								
3) Zero is included, excluded, forced								
4) Stds cover entire working range								
a. lowest std >MDL								
b. lowest std ≤ RL								
c. std ≤ reg limit								
5) Reasoning for discarded calibration points is documented								
B. Data								
1) Peaks are evaluated properly								
2) Manual integrations documented/valid								
3) Ensure no carryover to the MDL								
4) If 2 failed CCVs recal or 2 good CCVs								
5) Retention Time study done								
a. correct time period								
b. cbsolute RT set to/freq.								
c. curtain window using								
C. Electronic Audit Performed								

Supplemental Audit Checklist/Corrective Action list

Item	Y	N	NA	Comments	Correction needed	Analyst	Date Corrected by analyst	Date Approved by Auditor
Organics								
A. Calibration								
1) Type of curve used _____acceptable								
2) Nonlinear ok?								
3) Zero is included, excluded, forced								
4) Stds cover entire working range								
a. lowest std >MDL								
b. lowest std ≤ RL								
c. std ≤ reg limit								
d. stds processed/unprocessed								
e. surrogate at multi or single level								
5) Reasoning for discarded calibration points is documented								
6) Internal std evaluated properly/ how monitor								
B. Data								
1) Peaks are evaluated properly								
2) Manual integrations documented/valid								
3) Ensure no carryover to the MDL								
4) If 2 failed CCVs recal or 2 good CCVs								
5) Retention Time study done								
a. correct time period								
b. absolute RT set to/freq.								
c. curtain window using								
6) Long list LCS/MS-proper # analytes, rotate analytes in 2yr period								
7) Analytes consistently out are examined								
8) Non GCMS (pest/herb) confirm/ doc or hist								
9) Use of secondary Column Documented								
C. Electronic Audit Performed								
D. Extraction Spreadsheet correct								

Appendix N Sample Transportation for Third Party Couriers (SOP F14)

Sample Transportation for Third Party Couriers

Edward S. Babcock & Sons
STANDARD OPERATING PROCEDURE

Effective Date 04/30/10

1.0 Scope:

1.1 Environmental samples are transported to the laboratory either under the custody of E.S. Babcock & Sons, Inc. personnel or a commercial carrier. Both modes of transportation require United States Department of Transportation (DOT) regulations to be followed.

1.2 This document describes the basic guidelines that must be followed when transporting samples to the laboratory.

1.3 The courier company must maintain a current copy of this SOP in its entirety on file. All courier personnel must read, understand and agree to comply with all provisions of this SOP (A summary outline is included as attachment A, and it is suggested that it be carried by all courier personnel performing work for E.S. Babcock laboratories).

2.0 Transport conditions:

2.1 The third party courier ensures that the field conditions and transport of samples do not invalidate the results or adversely affect the required quality of any measurement. Any conditions that could affect the test results shall be documented.

2.1.1 Example: Neglecting to place the sample in the cooler immediately upon pick up, resulting in the sample being outside the cooler during a portion of the transit.

2.2 Bacti bottles, vials or other small sample containers which could possibly be submerged in ice or easily cross-contaminated must be placed inside zip-closure bags to avoid contamination from the melting ice. It is generally recommended that Bacti bottles be packed inside zip-closure bags when shipped, even if blue ice is used, to prevent contamination.

2.2.1 Do not combine different sample types inside one bag. If you have two different sample matrices, use a different bag for each matrix. Matrix information may be found on the chain of custody

2.2.2 Do not add ice inside the zip-closure bag with the sample. Doing so will continue to expose the sample to contamination.

2.2.3 Make sure bags are completely sealed and intact (no rips or holes) before placing them in the ice chest.

2.3 Upon pick up, samples must be properly secured and immediately chilled on ice (or blue ice) and transported to the laboratory. Samples must be kept cold from the time of sampling until analysis. If a sample arrives >6 °C without ice, the client is advised that the sample temperature may affect test results. This will be noted on the final report.

2.4 Drinking Water and Wastewater samples must be placed in separate coolers in order to minimize the possibility of cross contamination.

2.5 Holding Time: Prompt delivery to the laboratory is imperative

2.5.1 Bacti: Samples must be analyzed within 30 hours for drinking water, within 6 hours for wastewater, surface water, and storm water and within 8 hours for source water. .

2.5.2 Chem.: Samples have varying holding times. If samples will not be brought to the laboratory immediately, ask the lab for more information. (See SOP Q14)

3.0 Documentation:

3.1 Completed chain-of-custody forms can be placed in zip-closure type bags and taped to the underside of the cooler lids. Other methods of ensuring proper delivery of associated documentation may be acceptable.

3.2 The method of shipment and any unusual circumstances pertaining to the shipment must be recorded on the chain-of-custody form.

3.3 Sign the chain of custody form both when the samples are received and when the samples are delivered to the laboratory.

Approved by Susann K. Thomas Date 04/20/10

Attachment A
Sample Transportation for Third Party Couriers
Edward S. Babcock & Sons, Inc

This is a summary of the guidelines to be followed during sample transport by third party couriers. For detailed information about this subject, please read Edward S. Babcock & Sons, Inc. Standard Operating Procedure F14 in its entirety.

1. All samples must be transported on ice. Blue ice or wet ice.
2. Drinking water samples must be in a separate ice chest from wastewaters. Ask client or call lab if in doubt about the type of samples you are picking up.
3. Samples in Bacti bottles and VOA vials must be put in zip-lock bag before they are put in ice chest.
4. Make sure there is a label on all containers.
5. Chain of Custody forms and other documentation associated with the samples must accompany the samples delivered to the lab.
6. Wastewater, storm water, surface water and source water samples for Bacti analysis must be delivered to the lab within 5 hours of sampling. Call the lab if this holding time may be a problem.

Appendix O Training Module Outlines

Day with QA Training Outline

Topics to be covered:

1. Who are our clients and why are our services required?
    a. Clients: Our clients consist of private individuals, municipalities, WWTPs, private businesses, other laboratories, engineering firms and government contracts.
    b. Matrices: We analyze drinking water, wastewater, groundwater, stormwater runoff, solids (environmental soil, nonaqueous waste such as oils, paints, rock etc), sludges, and agricultural soils.
    c. Most of our clients are required by law to perform environmental testing as dictated by the following regulations.

2. Methods and Regulations.
    a. Regulations
        i. Drinking Water is regulated under the Safe Drinking Water Act, by the California Code of Regulations, Title 22.
        ii. Wastewater is regulated under the Clean Water Act, and NPDES, by 40 CFR 136.
        iii. Ground water and solid waste is regulated under SW846
    b. Methods: We must follow certified methods.
        i. Standard Methods for the Examination of Water and Wastewater
        ii. EPA Methods
        iii. ASTM

3. Special projects
    a. We do have special on-going projects. Some are continuous (year round) and then we have some quarterly and Semi-annuals. One of our biggest projects include the site at Stringfellow, which is done semi-annually in April and October.
    b. Projects will have special needs such as a faster turn around time or different QC.
    c. Project Managers are assigned to monitor these projects. As the analyst you must be aware of these differences (usually via notes that appear in the comments of your bench sheet) and ensure that they happen.

4. NELAP
    a. The laboratory is accredited by both ELAP (state) and NELAP (national). NELAP is the National Environmental Laboratory Accreditation Program, which is a national organization attempting to standardize laboratory accreditation. They insure that certain quality standards are in place for each laboratory under this accreditation. This allows clients to choose laboratories with certain minimum standards. Our quality assurance program is based on NELAP Standards. We are inspected biannually by NELAP to ensure implementation.

5. Sample flow from log in to reporting.
    a. Clients bring in samples
    b. Log in checks for sample acceptability and after accepting the samples, they log the samples in to the LIMS. They enter all sample information such as sample ID, sampler, time, temperature, analysis required. Sample status is **Received**.
    c. Samples that require further preservation are split out into separate containers. Some samples require interference screening and preservation. Preserved samples are checked to make sure that they are at the proper pH. Sample bottles are then placed in the proper refrigerator.
    d. The samples are then made available for the analysts. Analyst make lists from LIMS and the sample becomes **Batched**. The sample is **Prepped** and then analyzed. Results are entered into the computer. Qualifiers are added to notify client of any deviations or discrepancies. The analyst verifies all entered results, and updates status to **Needs Peer Review**
    e. A second analysts or a supervisor reviews the data a second time and checks for transcription errors, batch QC and qualifier correctness. The status is updated to **Analyzed**.
    f. A Supervisor then reviews data to verify that all analytes for any given sample match. Includes Ion ratios, and electrochemical balance. Status is updated to **Reviewed**, and at this point, the data is considered reportable.
    g. Front office queries the reportable status work orders, and pulls the work orders from the binders. Depending on the project and the specific requirements, the work order is handed to the PM, who makes sure all special requirements are met, and verify against historical data
    h. The reports are printed, and the PM's or the laboratory director signs the report. The status is **Reported**. The report is given back to the front office for copies and mailing, and invoicing.
    i. The report is mailed.

6. Holding times and Turn around Times SOP Q07 and Q14
    a. Turn Around Times (TAT): TAT is the time a sample takes from the time it comes in, to when the report comes out. The laboratory regular Turn Around Time is 7-10 Business days. Rush TAT's are also available and must be approved by the supervisor or analyst. The rush TAT's may be 24 hr, 48 hrs, 3 day, and the customary 4-5 day rush. Rushed samples take priority only if no holding times are compromised.
    b. Holding times: Holding time is the maximum times that samples may be held from sampled time to analysis and still be considered valid or not compromised. Meeting holding times is one of the most important responsibilities of analysts, as samples analyzed past holding time become questionable. If holding time is exceeded, the client needs to be notified to cancel and resample, or to report as qualified data. Holding times vary from analyte to analyte.

7. Initial Demonstration of Capability (IDoC) SOP A12
    a. IDoC's are a very important requirement of the training process. This procedure establishes the ability of the analyst to generate acceptable accuracy and precision. Sample analysis may not be performed until after a successful IDoC has been completed. Until then, the analyst is still considered to be in training, and may not perform the analysis by him/her self, his/her work must always be co-initialed by the trainer.
    b. To complete an IDoC, the analyst (by him/herself) must perform the specified procedure for the method in question. An IDoC is usually four replicates of a clean matrix, spiked at a level specified by the method (for example 5-50x MDL for Standard Methods or 1-4XRL if not specified).
    c. A checklist is available from the QA Department, and a form must be filled out, and submitted to QA.

8. Basic QC requirements (eg. What is a MB, LCS, MS, what makes up essential batch QC) SOP Q01
    a. Every batch must contain required Quality Control.
    b. Quality control is usually a
        i. Method Blank (MB), a sample of matrix similar to the batch of associated samples that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures, and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analysis.
        ii. Laboratory Control Spike (LCS, aka BS), a sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst specific precision and bias or to assess the performance of all or portion of the measurement system.
        iii. Matrix Spike (MS), a sample prepared by adding a known mass of target analyte to a specified amount of matrix sample for which an independent estimate of Target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
        iv. Matrix Spike Duplicate, a second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of the precision of the recovery for each analyte.
        v. Duplicate (Dup, BSD or MSD). Duplicate: Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
    c. The frequency and acceptance criteria of each of these components is designated by the method.
    d. Essential batch QC is a MB and one LCS

9. What is our in-house policy for when QC fails. SOP Q06
    a. MB: Target analyte results must be below the Reporting Limit. If above RL, samples less than 10X the contamination level must be flagged.
    b. LCS: All target analytes must fall within the laboratory established acceptance range.
        i. If you spike multiple analytes, it is possible to use marginal exceedance, and still consider your LCS as acceptable.
        ii. If bias high, but samples ND, OK to report.
    c. Corrective Action for failed MB or LCS:
        i. Examine the conditions of the instrument, calibration, reagents etc to determine if the problem might be systematic.
        ii. Re-analyze QC
        iii. If the re-analysis confirms the original failure, re-extract or redigest if sample is within holding time, and if there is sample left.
        iv. If it is past holding time or there is not enough sample, the client must be notified. Fill out a QC Follow up form for proper documentation.

10. QC Follow up forms and lab policy. SOP Q24
    a. An Analysis Dispute / QC Follow up form must be filled out every time the data has been affected due to a deviation from QC procedures, or method, or failure to meet laboratory acceptance criteria.
    b. The supervisor should be notified as soon as a deviation or non-conformance is noticed. The Reviewer, Supervisor, or project Manager immediately create a form, and update the status to pending. Investigation findings are documented on the form. Client Services contacts the client to advise of problem and investigation findings, and document approval to proceed or cancel. The status is updated accordingly, and desired corrective action is taken.

11. LIMS Training
    a. Standards and Reagent: See power point presentation
    b. Querying work: See power point
    c. Batching: See power point
    d. Entering Data

12. QA Manual (Walk through each section and focus on sections they need for signature sheet) Highlight a copy of the Table of Contents so that they know which parts to read.

13. QA Definitions SOP Q15

    a. Reporting Limit (RL) – The minimum level that an analyte can be reported to the client with a specific confidence level. Below this level the analyte is considered to be "none detected".

b. Method detection Limit (MDL) - The minimum concentration of an analyte that can be identified, based on a statistical calculation determined as specified in 40CFR, part 136, Appendix B. The MDL can also be referred to as the Level of Detection (LOD). Analytes reported down to the MDL are qualified as "J flagged" results.
c. Qualifiers – A note that is included with a sample result to indicate to the client a deviation from normal procedure.

14. Yearly QC requirements: SOP Q01
    a. Calibration curves are required on a yearly basis for spectrophometer analyses.
    b. LOD Checks are required for all certified analyses. It is a low standard analyzed as a verification of the MDL.
    c. Demonstration of Continuing Proficiency (DoCP), On an annual basis, each analyst must turn in valid LCS data from four consecutive LCS samples or results from a successful Proficiency Testing Study for every certified analytical procedure performed that year. LCS percent recovery must meet laboratory prescribed acceptance criteria. Relative standard deviation between the four replicates must be less than or equal to 20% for Inorganic analyses or 40% for Organic analyses.

15. Performance Testing program SOP Q26
    a. We are required by NELAP to participate in the PT program twice a year. In January and July we receive a series of standards whose true value is unknown to us:
        i. WS – drinking water testing
        ii. WP – wastewater testing
        iii. SOIL – solid testing
    b. Standards often are received in vials that must be diluted to a specified volume. After preparation, standards must be analyzed in the same manner as samples. Analysts may analyze a QC sample along with the PT. The QC value is unknown to the analyst but can be verified after analysis by QA.
    c. Results will be evaluated in a PT review session prior to reporting.
    d. We must participate in extra PT studies if an analyte fails two times in a row.

16. Internal audit process. SOP Q16

    Each certified method is audited on a yearly basis by a Quality Assurance Officer. This process is intended to use preventive action as a pro-active process to identify opportunities for improvement rather than a reaction to the identification of problems or complaints. The auditor performs the following functions:
        a) Reviews the content of the referenced method.
        b) Compares the published method to the existing SOP (Standard Operating Procedure).
        c) Observes the analyst(s) performing the analysis to:

- ensure that the SOP is being followed.
- ensure that all laboratory quality control requirements are being observed.
- define basic laboratory skills required for analysis and observe capability.
- identify training needs and provide training
- suggest technique improvements, preventive action as needed.
- expand analyst's knowledge about the method

d) Electronic Audit: Examination of chromatography integration, calibration, and LIMS data to ensure integrity between raw results and data entered into the LIMS. (see attachment 2)

e) Discusses with management any SOP variations that the analyst is performing, or any SOP procedures that vary significantly from the referenced method, in order to determine if corrective action is necessary.

f) Edits the SOP to reflect laboratory practice. Details any changes that will be implemented, and any method variations.

g) Issues analyst a written list of deficiencies with a given time table for corrective action. Follows up with analyst to ensure that deficiencies are corrected and proposed preventive actions are effective.

17. Data Reviewing: SOP Q10
    a. The analysts review raw data for the following:
        i. Results are calculated correctly. (Final results on the data page must be calculated, not copied from Element.)
        ii. Batch QC meets acceptance criteria.
        iii. Dilution or concentration factors were correctly applied and chosen appropriately.
        iv. Proper units were used.
        v. Results are reported accurately.
        vi. Additional reporting requirements were met (i.e. QC report, notes, special requirements).
    b. Once the analyst feels the data is acceptable, he/she enters the data into Element and reviews the entered data for the following:
        i. Raw and final results on the instrument report forms match the data in Element.
        ii. Dilution factors and initial/final sample volumes are correct.
        iii. MRL, initials of the chemist, date and time are correct..
        iv. All red data in Element is corrected or properly qualified.
    c. The peer reviewer checks raw data for the following:
        i. Calculations are correct. Spot check.
        ii. The batch meets acceptance criteria.
        iii. Proper documentation concerning QC failures, method deviations, elimination of calibration points, etc.
        iv. All comments or initials are properly dated.
    d. The peer reviewer checks the Peer Review Checklist for the following:
        i. Raw data matches notations made on the checklist.
        ii. QC failures are marked appropriately.
        iii. The Peer Review Checklist is filled out completely

iv. Initials and signatures are dated
v. All the necessary support data is present.
vi. Follow up actions are being taken. If it says that RE was created, double check in Element that it was done.

e. The peer reviewer checks the data in Element for the following:
i. Raw data matches Element entries.
ii. All samples and analytes have answers.
iii. The bench sheet matches the data in Element.
iv. Units and reporting limits are correct.
v. All red data is qualified correctly. Check that the qualifiers are correct for the problem associated with the data. Remember that there may be some issues that require qualifiers but do not turn red.

f. After the peer reviewer, Supervisors and Project Managers verify results as stated above.

18. Instrument maintenance logs SOP Q21
    a. Records shall be maintained of each major type of equipment and all reference materials significant to the tests being performed. These records include documentation on all routine and non-routine maintenance activities.

19. Basic Safety/chemical hygiene (orientation to lab safety CD.)
20. SOP 'Modules' (please make suggestions as to how these should be split).
21. Basic Skills orientation/training
    a. Autopipette use and calibration
    b. Glassware
    c. Balances

Microbiology
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Signature sheet Due:_____
   1.4 Major points

2. Basic Safety/Chemical Hygiene
   2.1 Chemical Hygiene Tour Safety Quiz Due:_____
   (fill out checklist)
   2.2 Orientation to Lab Safety CD
   2.3 MSDS Cabinet in Study
   2.4 Basic Safety Guidelines
   2.5 Emergency Plans/Quiz

3. Training Procedure (A12)
   3.1 Training steps
   3.2 Training Packet
   3.3 Standard Operating Procedures
   3.4 Initial Demonstration of Capability

3.5 Resume – Statement of Qualification
3.6 Training Paperwork

- **LIMS/QC**

1. LIMS Training
   1.1 What is LIMS?

2. Yearly QC Requirements
   2.1 Demonstration of Continuing Performance
   2.2 Performance Testing Program (Q26)
   2.3 Internal Audit Program (Q16)

3. Document Control

SOP Assignment for Module 1 to be completed by:_____

- **Module #2 (3 hours) Performed on _____by_____**

1. Ethics

1.1 Ethics Quiz Due:_____

- **Module #3 (4 hours) Performed on _____by_____**

Quality Control (B01)

1. Incubators, Water Baths and Dry Oven
2. Autoclave
3. Biological Indicator of Sterilization Efficiency
4. Incubator Designation and Quality Control
5. Cleaning Instructions
6. Sample Containers
7. Equipment Calibration and Maintenance (Q21)
8. Quality Control
9. Determination of pH on media
10. Corrective Action For Out of Control Or Unacceptable Data
11. Pollution Prevention and Waste Management
12. House Keeping

SOP Assignment for Module 3 to be completed by:_____

- **Module #4 (3 hours) Performed on _____ by_____**

1. Reference Cultures, Media, and Reagents
   - 1.1 Definitions: What is a reference culture/reagent?
   - 1.2 Importance of Traceability
   - 1.3 Logs and Labeling and Quality Control
   - 1.4 Reagent Quality and Safety

SOP Assignment for Module 4 to be completed by:_____

- **Module #5 (3 hours) Performed on _____ by_____**

1. Extended LIMS Training/QC Requirements
   - 1.1 Data Entry(A11)
     - 1.1.1 Entering Data
   - 1.2 Qualifiers (Q22)
   - 1.3 In house policy for when QC fails (Q24)
     - 1.3.1 Follow up forms, "Root Cause" Analysis, etc.

SOP Assignment for Module 5 to be completed by:_____

SOP Reading Assignments

Module #1	**Module #3**	**Module #4**	**Module #5**
SOP Read List #1	SOP Read List #2	SOP Read List #3	SOP Read List #4
A08	B01	Q05	A11
A12	Q21	S01	B08
Q07		S03	Q22
Q09		S05	Q24
Q14			
Q15			
Q23			
Q26			
S07			

QAManual - Introduced in Module #1, due by the end of Module #4 (approximately 2 week from hire date).
Estimated hours for each module includes SOP reading time.

- **Complete Statement of Qualifications by _____**
  - (Nas_server/QA_Dept/Resumes/Example Resume for)

SKT 8/07/07

1. Standards and Reagents
   1.1 What is a standard/reagent?, logging in standards (Presentation)
   1.2 (Exercise)?

SOP Assignment for Module 4 to be completed by:_____

- **Module #5 (3 hours) Performed on _____ by_____**

1. Extended LIMS Training/QC Requirements
   1.1 Data Entry
      1.1.1 Entering Data
         11.2 Date Review/Validation (Q10)
   1.2 Qualifiers (Q22)
   1.3 Rounding Numbers and Sig. Figs (Q04)
   1.4 In house policy for when QC fails (Q24)
      1.4.1 Follow up forms, "Root Cause" Analysis, etc.

SOP Assignment for Module 5 to be completed by:_____

SOP Reading Assignments (*depends on position)

Module #1	**Module #3**	**Module #4**	**Module #5**
SOP Read List #1	SOP Read List #2	SOP Read List #3	SOP Read List #4
A06			
A11	Q04	Q05	Q06
A12	Q09	Q08	Q10
Q01	Q21	S01	Q18*
Q07	S04	S02*	Q20*
Q14		S03	Q22
Q15		S05	Q24
Q23		S06	
Q26			
S07			

QAManual - Introduced in Module #1, due by the end of Module #4 (approximately 2 week from hire date).
Estimated hours for each module includes SOP reading time.

- **Complete Statement of Qualifications by _____**
  - (Nas_server/QA_Dept/Resumes/Example Resume for)

SKT 5/29/07

Chemistry
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Signature sheet Due:_____
   1.4 Major points

2. Basic Safety/Chemical Hygiene
   2.1 Chemical Hygiene Tour Safety Quiz Due:_____
   (fill out checklist)
   2.2 Orientation to Lab Safety CD
   2.3 MSDS Cabinet in Study
   2.4 Basic Safety Guidelines
   2.5 Emergency Plans/Quiz

3. Training Procedure (A12)
   3.1 Training steps
   3.2 Training Packet
   3.3 Standard Operating Procedures
   3.4 Initial Demonstration of Capability

3.5 Resume – Statement of Qualification
3.6 Training Paperwork

- **LIMS/QC**

1. LIMS Training
   1.1 What is LIMS?

2. Basic QC Requirements
   2.1 What is a batch?
   2.2 Basic Batch QC Requirements
   2.3 Reporting Level Definitions

3. Yearly QC Requirements
   3.1 Calibration Curves
   3.2 LOD Checks
   3.3 Demonstration of Continuing Performance
   3.4 Performance Testing Program (Q26)
   3.5 Internal Audit Program (Q16)

4. Document Control

SOP Assignment for Module 1 to be completed by:_____

- **Module #2 (3 hours) Performed on _____by_____**

1. Ethics

1.1 Ethics Quiz Due:_____

- **Module #3 (3 hours) Performed on _____by_____**

1. Basic Skills/Technique (Depending on the Position) (Q04)
   1.1 Glassware: Proper care, cleaning, etc.
   1.2 Pipettes: Autopipette use and calibration
   1.3 Syringes: certificates, care, etc.
   1.4 Balances, Thermometers, (Refrigerator, ovens, incubators): When calibrated, checked, etc.
   1.5 Maintenance Logs: Instrumentation, Hoods, etc. What is a maintenance log, In and out of service, document maintenance, etc. (Q21)

SOP Assignment for Module 3 to be completed by:_____

- **Module #4 (3 hours) Performed on _____ by_____**

Project Management
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Signature sheet Due:_____
   1.4 Major points

2. Basic Safety/Chemical Hygiene
   2.1 Chemical Hygiene Tour Safety Quiz Due:_____
   (fill out checklist)
   2.2 Planning for Lab Emergencies Safety CD
   2.3 Basic Safety Guidelines
   2.4 Emergency Plans/Quiz

3. Misc. QA Documentation
   3.1 Standard Operating Procedures
   3.2 Resume – Statement of Qualification
   3.3 Training Paperwork

- **LIMS/QC**

1. LIMS Intro
   1.1 What is LIMS?

2. Basic QC Requirements
   2.1 What is a batch?
   2.2 Basic Batch QC Requirements
   2.3 Reporting Level Definitions

3. Yearly QC Requirements
   3.1 Performance Testing Program (Q26)
   3.2 Internal Audit Program (Q16)

4. Document Control (A02)
   4.1 Forms
   4.2 Log Book Corrections (Q09)

- **Sample Receiving, Handling and Storage**

1. Chain of Custody

CoC
Sample Receipt Form
Legal Chain of Custody (A01)

2. Sample handling (S04) and acceptability (A08)

Handling
Temperature
Acceptability

3. Sample login (A03) and customer information (A04)
4. Sample storage (A06)

SOP Assignment for Module 1 to be completed by:_____

- **Module #2 (3 hours) Performed on _____by_____**

1. Ethics

1.1 Ethics Quiz Due:_____

- **Module #3**

1. LIMS Training

Sample Control
Laboratory
Project Management
QA Admin
Database Admin

- **Module #4 (3 hours) Performed on _____ by_____**
  1. Extended PM Requirements
     1.1. Review of Contracts and Tenders (A13)
     1.2. Client confidentiality
     1.3. Work Orders
     1.4. Data/Report review
     1.5. Qualifiers (Q22)
     1.6. Rounding Numbers and Sig. Figs (Q04)
     1.7. In house policy for when QC fails (Q06, Q24)
        1.7.1. Follow up forms, "Root Cause" Analysis, etc.
     1.8. Deliverables

SOP Assignment for Module 5 to be completed by:_____

SOP Reading Assignments (*depends on position)

Module #1	**Module #3**	**Module #4**
SOP Read List #1	SOP Read List #2	SOP Read List #3
A01	A04	A10
A02	A05	A13
A03	Q03	Q06
A04		Q10
A08		Q22
Q01		Q24
Q07		
Q09		
Q14		
Q15		
Q23		

QAManual - Introduced in Module #1, due by the end of Module #4 (approximately 2 week from hire date).
Estimated hours for each module includes SOP reading time.

- **Complete Statement of Qualifications by _____**
  - (Nas_server/QA_Dept/Resumes/Example Resume for)

SKT 5/29/07

Marketing
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times (Q07, Q14)

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Signature sheet Due:_____
   1.4 Major points

2. Basic Safety/Chemical Hygiene
   2.1 Chemical Hygiene Tour Safety Quiz Due:_____
   (fill out checklist)
   2.2 Planning for Lab Emergencies Safety CD
   2.3 MSDS Cabinet in Study

3. Standard Operating Procedures (Q23)

- **LIMS/QC**

1. LIMS Training
   1.1 What is LIMS?

2. Basic QC Requirements (Q15)
   2.1 What is a batch?

2.2.1 Basic Batch QC Requirements
2.2.2 QC Follow up form
2.3 Reporting Level Definitions

3. Yearly QC Requirements
   3.1 Performance Testing Program
   3.2 Internal Audit Program

4. Document Control (A02)
   4.1 Forms
   4.2 Log Book Corrections (Q09)

- **Sample Receiving, Handling and Storage**

1. Chain of Custody

CoC
Sample Receipt Form
Legal Chain of Custody (A01)

2. Sample handling (S04) and acceptability (A08)

Handling
Temperature
Acceptability

3. Sample login (A03) and customer information (A04)
4. Sample storage (A06)

SOP Assignment for Module 1 to be completed by:_____
A01, A02, A04, A08, A13, Q07, Q09, Q14, Q15, Q23,

- **Module #2 (2 hours) Performed on _____by_____**

1. Ethics

1.1 Ethics Quiz Due:_____

Estimated hours for each module includes SOP reading time.

Login
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times (Q07, Q14)

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Signature sheet Due:_____
   1.4 Major points

2. Basic Safety/Chemical Hygiene
   2.1 Chemical Hygiene Tour Safety Quiz Due:_____
   (fill out checklist)
   2.2 Planning for Lab Emergencies Safety CD
   2.3 MSDS Cabinet in Study

3. Standard Operating Procedures (Q23)

- **LIMS/QC**

1. LIMS Training
   1.1 What is LIMS?

2. Basic QC Requirements (Q15)
   2.1 What is a batch?

2.2.1 Basic Batch QC Requirements
2.2.2 QC Follow up form
2.3 Reporting Level Definitions

3. Yearly QC Requirements
   3.1 Performance Testing Program
   3.2 Internal Audit Program

4. Document Control (A02)
   4.1 Forms
   4.2 Log Book Corrections (Q09)

- **Sample Receiving, Handling and Storage**

1. Chain of Custody
CoC
Sample Receipt Form
Legal Chain of Custody (A01)
2. Sample handling (S04) and acceptability (A08)
Handling
Temperature
Acceptability
3. Sample login (A03) and customer information (A04)
4. Sample storage (A06)

SOP Assignment for Module 1 to be completed by:_____
A01, A02, A03, A04, A08, Q07, Q09, Q14, Q15, Q23, S04

- **Module #2 (2 hours) Performed on _____by_____**

1. Ethics
1.1 Ethics Quiz Due:_____

- **Module #3 (2 hours) Performed on _____by_____**

2. Sample splitting, compositing and preservation
Bottle Preparation (A09)
Sample splitting and preservation (A06, S01, S03)
Proper compositing techniques
SOP Assignment for Module 3 to be completed by:_____
A06, A09, S01, S03

Estimated hours for each module includes SOP reading time.

Field
Quality Assurance Training Schedule
New Employee_____

- **Module 1 (8 hours) Performed on _____ by_____**
  - **Introduction to ESB**

1. NELAP
   1.1 What is NELAP and its importance?

2. Methods and Regulations
   2.1 Regulations
   2.2 Methods

3. Clients and Projects
   3.1 Who are our clients and why are our services required?
   3.2 Special projects

4. Production
   4.1 Sample flow
   4.2 Holding Times and Turn Around Times (Q07, Q14)

- **QA Manual/Safety/Training Overview**

1. QA Manual
   1.1 Contents
   1.2 Location
   1.3 Major points
   1.4 Signature sheet/quiz Completed on:_____

2. Basic Safety/Chemical Hygiene
   2.1 Safety/Chemical Hygiene Tour Given On:_____
   (fill out checklist)
   2.2 Overview of Safety Quizzes
   2.3 MSDS Cabinet in Study

- **Field Work Precautions**
  1. Work Area
  2. Safety Attire and Equipment
  3. General Safety Precautions for Driving
  4. Physical Precautions

- **SOPs/LIMS/QC**
  1. Standard Operating Procedures (Q23)
  2. LIMS Training
     2.1. What is LIMS?
  3. Yearly QC Requirements
     3.1. Internal Audit Program
     3.2. Performance Testing Program
  4. Document Control (A02)
     4.1. Forms
     4.2. Log Book Corrections (Q09)

SOP Assignment for Module 1 to be completed by:_____
A12, Q09, Q14, Q15, Q23, S07, F11

- **Module #2 (2 hours) Performed on _____by_____**
  - **Ethics**
    1.1 Ethics Quiz

- **Module #3 (4hours) Performed on _____by_____**
  - **Field Sampling, Handling and Recordkeeping**

1. Sampling
   1.1. Bottle Preparation
   1.2. Sampling
      1.2.1. Equipment and Conditions
      1.2.2. Bacteriological Sampling
      1.2.3. 24 Hour Composite Sampling
      1.2.4. Wastewater Grabs
      1.2.5. Programming the ISCO Sampler Model 2900
      1.2.6. Copper/Lead Sampling
      1.2.7. Sampling of Volatiles
2. Field Recordkeeping
   2.1. Sample Identification
   2.2. Chain of Custody
   2.3. Legal Chain of Custody
   2.4. Log Book
3. Handling
   3.1. Sample Transportation
   3.2. Sample Handling and Acceptability
   3.3. Sample login and Customer Information
   3.4. Proper Composition Techniques

3.5.Sample Splitting and Preservation
3.6.Sample Storage

SOP Assignment for Module 3 to be completed by:_____
A08, A09, Q21, S01, S03, So4, F02, F03, F06

- **Module #4 (2 hours) Performed on _____by_____**
  - **Additional Field Sampling, Field Analyses**

1. Sampling Procedures
   1.1.Groundwater Sampling
   1.2.DO
   1.3.Sulfide
2. Field Analyses
   2.1.Cl Residual
   2.2.pH
   2.3.Temperature

SOP Assignment for Module 4 to be completed by:_____
F04, F05, F07, F08, F09, F10

Note: This is the last page of the QA Manual (version effective July 1, 2011)

Appendix C